WESTFIELD RIVER WATERSHED

KNIGHTVILLE DAM

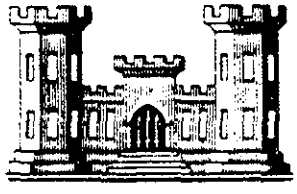
LITTLEVILLE LAKE

MASSACHUSETTS & CONNECTICUT

CONNECTICUT RIVER BASIN

MASTER MANUAL OF WATER CONTROL

APPENDIX H



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

JANUARY 1978

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App.D Vermont -- App.B. Ottauquechee River
1973 watershed, Vermont -- App.C. Black
River watershed, Vermont -- App.D. West
River watersh ed, Vermont -- App.E.
Ashuelot Rive r watershed, New
Hampshire and Massachusetts --
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1983 of water control, New Hampshire,
Vermont, Massachusetts, Connecticut.
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Hampshire and Massachusetts -- App.G.
Chicopee River watershed, Massachusetts
-- App.H. Westfield River watershed,
Massachusetts and Connecticut -- App.J.
Farmington River watershed, Connecticut
and Massachusetts.

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watershed. 2. Flood control--
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dams and reservoirs--Connecticut River
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CONNECTICUT RIVER BASIN
MASTER MANUAL
OF
WATER CONTROL

APPENDIX H

WESTFIELD RIVER WATERSHED
KNIGHTVILLE DAM
LITTLEVILLE LAKE
MASSACHUSETTS AND CONNECTICUT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

JUNE 1967
REVISED JANUARY 1978

PREFACE

The Westfield River watershed has a drainage area of 517 square miles and is located in western Massachusetts, with a small portion in north-central Connecticut. The flood control system for the watershed described in this manual includes two dams and reservoirs, namely, Knightville Dam and Littleville Lake, and the West Springfield Local Protection Project. Knightville Dam is located in Huntington and Chesterfield, Massachusetts and Littleville Lake is in Huntington and Chester, Massachusetts. The West Springfield Local Protection Project is located at the mouth of the Westfield River in West Springfield.

This Appendix of the Connecticut River Master Manual of Water Control includes a description of the watershed, hydrologic, climatological and flood data, together with project descriptions and regulation procedures for Corps reservoirs. In addition to setting forth a method of water control, the manual will serve as a reference source for future studies.

The manual is divided into seven chapters: Introduction, Management, Hydrometeorology, Communications, Hydrologic Forecasts, Reservoir Regulation and Hydrologic Equipment. The setup of chapters allows the reader to obtain desired general background information on any particular aspect of each project.

Pertinent data on the hydrologic information of the Westfield River watershed, Knightville Dam and Littleville Lake are shown on pages i, ii, iii, respectively, at the front of the manual.

The chapter on reservoir regulation contains detailed procedures and information necessary for regulating the protective works to provide protection for downstream communities on the Westfield and Connecticut Rivers.

CONNECTICUT RIVER BASIN

MASTER MANUAL OF WATER CONTROL

Appendix	Watershed	Reservoir	Status
Master Manual	Connecticut River	-	Started
A	Ompompanoosuc R.	Union Village	Completed 1950 (Revised 1971)
B	Ottauquechee River	North Hartland	Completed 1969
C	Black River	North Springfield	Completed 1968
D	West River	Ball Mountain Townshend	Completed 1965 (Revised 1973)
E	Ashuelot River	Surry Mountain Otter Brook	Completed 1962 (Revised 1972)
F	Millers River	Birch Hill Tully	Completed 1950 (Revised 1974)
G	Chicopee River	Barre Falls Conant Brook	Completed 1964
H	Westfield River	Knightville Littleville	Completed 1967 (Revised 1978)
J	Farmington River	Colebrook River Mad River Sucker Brook	Completed 1970

MANUAL OF WATER CONTROL
WESTFIELD RIVER WATERSHED
MASSACHUSETTS AND CONNECTICUT

APPENDIX H

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WESTFIELD RIVER
WATERSHED
HYDROLOGIC INFORMATION

July 1977

Drainage Area	Square Miles
Main Stem - Westfield River	
At Knightville Dam	162
Above the Middle Branch	169
Below the Middle Branch	222
Above the West Branch	226
Below the West Branch	322
Above the Westfield Little River	367
Below the Westfield Little River	452
At the Westfield Gage	497
At the Mouth	517
Tributaries	
Swift River at Mouth	31.5
Dead Branch of Westfield River at Mouth	21.4
Middle Branch of Westfield at Littleville Lake	52.3
Middle Branch of Westfield at Mouth	53.0
West Branch of Westfield at Mouth	96.0
Westfield Little River at Cobble Mtn. Reservoir Outlet	45.8
Westfield Little River at Mouth	84.9
Powdermill Brook at the Mouth	20.0
Great Brook at the Mouth	30.2

Precipitation	Springfield, MA (inches)	Westfield River nr. Westfield, MA (inches)	Knightville Dam (inches)	Chester, MA (inches)
Mean Annual	43.7	45.2	43.6	48.4
Max Annual	62.6	70.3	62.3	76.2
Min Annual	31.0	29.7	32.2	32.2
Yrs. of Record (through 1975)	128	70	27	58

WATER EQUIVALENT IN SNOW COVER
(Based on Corps of Engineers Surveys)

	Mean (Inches)	Maximum (Inches)	Minimum (Inches)
1 February	2.0	5.0	0.4
15 February	2.7	7.4	0.1
1 March	3.2	8.0	0
15 March	3.4	8.5	0
1 April	2.3	9.3	0
15 April	0.5	4.0	0

USGS GAGES	Drainage Area (Sq. Mi.)	Tributary	Period of Record
Westfield River at Knightville	162.0	Westfield R.	1909-Present
Sykes Brook at Knightville	1.6	Sykes Brook	1945-Present
Middle Branch at Goss Heights	52.6	Middle Branch	1910-Present
Walker Brook near Becket Center	3.0	Walker Brook	1962-Present
West Branch at Huntington	93.7	West Branch	1935-Present
Westfield Little River at Cobble Mtn. Res.	45.8	Little River	1905-Present
Great Brook near Westfield, MA	29.2	Great Brook	1972-Present
Westfield River near Westfield	497.0	Westfield R.	1914-Present

PEAK FLOWS

Westfield River at Westfield, MA

Date	CFS	CSM
19 Aug 1955	70,300 (1)	142
22 Sep 1938	55,500	111
18 Mar 1936	48,200	97
4 Nov 1927	42,500	87

Middle Branch at Goss Heights, MA

Date	CFS	CSM
21 Sep 1938	19,900	380
19 Aug 1955	16,500	320
31 Dec 1948	9,600	182
18 Mar 1936	8,400	160

Westfield River at Knightville, MA

Date	CFS	CSM
21 Sep 1938	37,900	234
18 Mar 1936	25,700	158
31 Dec 1948	24,000 (2)	148
15 Oct 1955	20,000 (2)	117
19 Aug 1955	16,000 (2)	95

West Branch at Huntington, MA

Date	CFS	CSM
19 Aug 1955	26,100	278
21 Sep 1938	21,800	232
18 Mar 1936	14,400	153
15 Oct 1955	12,400	133
31 Dec 1948	12,100	129

(1) Computed natural at Westfield = 81,000 CFS
(2) Computed peak inflow into Knightville Dam

ANNUAL RUNOFF (1)

Westfield River near Westfield, MA

	CFS	Inches	Year
Mean	941	25.7	61 yrs
Maximum	1,590	44.1	1928
Minimum	368	11.5	1965

Westfield River at Knightville, MA

	CFS	Inches	Year
Mean	321	26.9	66 yrs
Maximum	537	45.1	1928
Minimum	137	11.5	1965

Middle Branch near Goss Heights

	CFS	Inches	Year
Mean	103	26.5	65 yrs
Maximum	182	47.1	1928
Minimum	43	11.0	1965

West Branch near Huntington, MA

	CFS	Inches	Year
Mean	182	27.0	40 yrs
Maximum	287	41.7	1956
Minimum	74	10.7	1965

(1) Through Water Year 1976

FLOOD ROUTING COEFFICIENTS

Reach	Routing Coefficients	River Miles Between Points
Knightville Dam to Westfield Gage	3/1-3 hr	16
Littleville Lake to Westfield Gage	3/1-3 hr	16
Westfield Gage to Mouth	3/1-3 hr	8

HIGH FLOW TRAVEL TIMES

	Time of Travel
Knightville to Westfield Gage	4 to 5 hours
Littleville to Westfield Gage	4 to 5 hours
Westfield Gage to Mouth of Westfield River	3 to 4 hours
Montague City to Springfield	12 to 15 hours
Springfield to Hartford	15 to 20 hours

PERTINENT DATA
KNIGHTVILLE DAM

July 1977

LOCATION — Westfield River; Huntington, Massachusetts

DRAINAGE AREA — 162 Square Miles

STORAGE USES — Flood Control

RESERVOIR STORAGE

	Elevation (ft msl)	Stage (ft)	Area (acres)	Capacity: Acre-Feet	Capacity: Inches on Drainage Area
Inlet Elevation	480	-	-	-	-
Spillway Crest	610	130	960	49,000	5.6
Maximum Surcharge	625	145	1,400	64,000	7.4
Top of Dam	630	150	-	-	-

EMBANKMENT FEATURES

Type	Rolled rock and earth fill, rock slope; protection, impervious core
Length (feet)	1,200
Top Width (feet)	30
Top Elevation (ft msl)	630
Maximum Height (feet)	160
Volume (cubic yards)	1,240,000
Dikes	None

SPILLWAY

Location	Right abutment
Type	Chute spillway, ogee weir
Crest Length (feet)	400
Crest Elevation (ft msl)	610
Surcharge (feet above crest)	15 (elevation 625)
Max. Discharge Capacity (cfs)	83,000

SPILLWAY DESIGN FLOOD

	Original Design	1975 Analysis
Peak Inflow (cfs)	88,700	145,000
Peak Outflow (cfs)	87,500	137,000
Volume of Runoff (acre-feet)	121,000	152,000

OUTLET WORKS

Type	One circular tunnel
Tunnel Diameter (ft)	16
Tunnel Length (ft)	605
Service Gate Type	Electrically operated gear-driven slide
Size	Three, 6'0" wide x 12'0" high
Channel Capacity	4,500 cfs
Discharge at Spillway Crest	14,500 cfs

LAND ACQUISITION

Fee Elevation (ft msl)	610
Fee (acres)	2,430
Easement (acres)	258
Clearing Elevation (ft msl)	540

MAXIMUM POOL

Date	January 1949	October 1955
Stage (feet)	130.2	127.8
Elevation (ft msl)	610.2	607.8
Percent Full	100+	96

UNIT RUNOFF

One inch runoff (acre-feet) — 8,630

OPERATING TIME

Open/close all Gates (ft/min) — 1 ft/min

PROJECT COST (THROUGH FY 76) — $3,288,000

DATE OF COMPLETION — December 1941

MAINTAINED BY — New England Division, Corps of Engineers

PERTINENT DATA
LITTLEVILLE LAKE

July 1977

LOCATION — Middle Branch Westfield River; Chester and Huntington, Mass.

DRAINAGE AREA — 52.3 Square Miles

STORAGE USES — Flood Control, Water Supply

RESERVOIR STORAGE

	Elevation (ft msl)	Stage (ft)	Area (acres)	Acre-Feet	Inches on Drainage Area
Bottom of Water Supply Pool	432	0	0	0	0
Bottom of Flood Control Pool	518	81	275	9,400	3.4
Spillway Crest	576	144	510	23,000 (net)	8.3 (net)
Maximum Surcharge	591	159	584	31,200 (net)	11.2 (net)
Top of Dam	596	164	-	-	-

EMBANKMENT FEATURES

Type	Rolled rock and earth fill, rock slope protection, impervious core
Length (feet)	1,360
Top Width (feet)	25.0
Top Elevation (ft msl)	596
Maximum Height (feet)	164
Volume (cubic yards)	1,900,000
Dike	Left abutment - 935' long by 46' high

SPILLWAY

Location	Left abutment
Type	Ogee weir, chute spillway
Crest Length (feet)	400
Crest Elevation (msl)	576
Surcharge (feet above crest)	15

SPILLWAY DESIGN FLOOD

	Original Design
Peak Inflow (cfs)	98,000
Peak Outflow (cfs)	92,000
Volume Runoff (acre-feet)	62,500

OUTLET WORKS

Flood Control

Type	Horseshoe conduit
Tunnel Diameter (ft)	8
Tunnel Length (ft)	374
Gate Type	Electronically Operated Sluice
Gate Size	Two - 4' wide x 8' high
Invert Elevation (ft msl)	513(1)
Downstream Channel Capacity	1,500 cfs +
Discharge at Spillway Crest	2,270 cfs

(1) Discharge channel drops from 518 feet msl at weir (bottom of flood control pool) to 513 feet msl at the gate

Water Supply (City of Springfield, Mass.)

Type	Concrete conduit
Tunnel Diameter (ft)	4
Tunnel Length (ft)	800

Gates

Gate (No.)	Size ("in Diam.)	Type	Invert Elevation
1 (inlet)	36	Sluice	502.2
2 "	36	Sluice	483.8
3 "	36	Sluice	465.4
4 "	36	Sluice	447.0
5 (outlet)	48	Butterfly Valve	432.0
6 (drain)	46x48	Sluice	432.0
7 (mud gate)	12	Sluice	432.0

LAND ACQUISITION

Fee Elevation (ft msl)	581
Fee (acres)	1,567
Easement (acres)	10
Clearing Elevation (ft msl)	523

MAXIMUM POOL

Date	Mar 1977
Stage (feet)	120.6
Elevation (msl)	548.6
Percent Full	46

UNIT RUNOFF

One Inch Runoff — 2,790 acre-feet

OPERATING TIME

Open/Close flood control gates — 5 feet/min

PROJECT COSTS (THROUGH FY 76) — $7,013,000

DATE OF COMPLETION — October 1965

MAINTAINED BY — New England Division, Corps of Engineers

MANUAL OF WATER CONTROL
WESTFIELD RIVER WATERSHED
MASSACHUSETTS AND CONNECTICUT

CHAPTER I

INTRODUCTION

1. REGULATION MANUAL

a. Authorization. This report is prepared pursuant to authority contained in ER 1110-2-240, dated 22 April 1970, "Reservoir Regulation" and EM 1110-2-3600, dated 25 May 1959, which requires that manuals of reservoir regulation for flood control, navigation or multipurpose reservoirs be prepared whenever storage allocated to one or more of the functions is the responsibility of the Corps of Engineers. Requirements given in the draft of "A Guide for Preparing Water Control Manuals for Lakes, Reservoirs, Locks and Dams, Hurricane Barriers, Reregulating Structures, Controlled Channels and Floodways, Office, Chief of Engineers," January 1973, were generally followed in the preparation of this manual.

b. Purpose and Scope. This manual will serve as a guide and reference source for higher authority, reservoir regulation and maintenance personnel of the New England Division, respective Project Managers and other personnel who may become concerned with, or responsible for, regulation of the reservoirs in the Westfield River watershed. Included in the manual are the following chapters:

(1) Introduction. A general history of flood problems and studies which led to the authorization of the Westfield River watershed flood control projects, including statistical data relative to population, industry and agriculture and a description of the physical features of all Corps and Soil Conservation Service projects.

(2) Management. A general description of the functional responsibilities of the Corps in regard to regulation of the projects, as well as a description of any interagency agreements or working relationships.

(3) Hydrometeorology. A general description of the watershed and major tributaries, including topographic features and a general coverage of the hydrologic and meteorologic data, i.e., temperature, precipitation, snowfall, snow cover, storms, streamflow and floods.

(4) Communications. A description of the means of reporting from field to office, as used by the Project Managers during nonflood and flood periods, and of the river reporting network and Automatic Hydrologic Radio Reporting System.

(5) Hydrologic Forecasts. A presentation of forecasts used by the Reservoir Control Center in regulating the projects in the basin.

(6) Reservoir Regulation. A detailed discussion of the regulation procedures and watershed flood control plan for two flood control reservoirs.

(7) Hydrologic Equipment. A brief resume of hydrologic equipment used and means of maintaining it.

c. Related Manuals. Routine operations and maintenance activities at Knightville Dam and Littleville Lake are performed by the Project Managers under the supervision of the Reservoir Branch of the Operations Division and in accordance with procedures outlined in Operation and Maintenance Manuals prepared for each project.

The Knightville Dam and Littleville Lake Operation and Maintenance Manuals of June 1972 provide essential operation and maintenance instructions to operating personnel for the upkeep, repair, maintenance and operations of project facilities.

2. KNIGHTVILLE AND LITTLEVILLE PROJECT DESCRIPTIONS

a. Location. The Westfield River watershed (plate H-3) is located on the eastern slopes of the Berkshires in western Massachusetts and northern Connecticut. Plates H-1 and H-2 show the upper and lower Connecticut River basin.

Knightville Dam is located in west-central Massachusetts on the Westfield River, 4 miles north of Huntington, Massachusetts

and about 27.5 miles above the confluence of the Westfield and Connecticut Rivers in West Springfield, Massachusetts. A vicinity and reservoir map of Knightville is shown on plate H-4.

The Littleville Reservoir is located on the Middle Branch of the Westfield River in Huntington and Chester, and the dam is about one mile upstream of the confluence of the Middle Branch and the Westfield River. A reservoir map and general plan of the Littleville Dam and Reservoir are shown on plates H-5 and H-9.

b. Purpose. Both Knightvile Dam and Littleville Lake are regulated to reduce flood stages at Westfield, West Springfield, and other communities on the Westfield River and, in conjunction with 14 other projects in the reservoir system, to reduce downstream flood stages along the Connecticut River. In addition, water-based recreational activities are utilized at both projects, and a water supply pool is maintained at Littleville Lake for the city of Springfield.

c. Physical Components

(1) Knightville Dam. Important project components consist of a hydraulic earthfill dam, a rock chute-type spillway with concrete weir, outlet works, storage capacity for flood control, and recreational facilities.

At spillway crest elevation, 610 feet msl, Knightville Reservoir has a capacity of 49,000 acre-feet, equivalent to 5.6 inches of runoff from the contributing drainage area of 162 square miles. When filled to spillway crest, the reservoir will extend about six miles and have a surface area of about 960 acres.

The dam embankment, about 1,200 feet in length and maximum height of 160 feet above streambed, consists of hydraulic earthfill and is shown on plate H-6. The top of dam at elevation 630 feet msl provides 15 feet of spillway surcharge and 5 feet of freeboard. The top width of 30 feet accomodates a 20-foot paved access road and the embankment slopes vary from 1 on 2.5 to 1 on 3.0.

The spillway is located on the right abutment adjacent to the dam. Components of the spillway include the approach channel, discharge channel and an uncontrolled curved concrete ogee weir

with a fixed crest at elevation 610 feet msl (130-foot stage) and a length of 400 feet. Plan, profile and cross section of the spillway are shown on plate H-7.

The outlet works are in the right abutment and consist of an intake channel 280 feet in length and a 16-foot diameter tunnel through rock. The tunnel is 605 feet in length and discharges are controlled by three 6-foot wide by 12-foot high broome gates mechanically operated through a control tower. Provision for the installation of a penstock for future development of hydroelectric power is included. Plan and sections of the outlet works are shown on plate H-8.

Principal recreational activities at Knightville are picnicking, hiking, hunting and sightseeing. Facilities for camping are also available in the Indian Hollow camping area in the upper end of the reservoir.

(2) Littleville Lake. Important physical components at Littleville Lake consist of a rolled earth dam and dike, a chute spillway composed of a concrete ogee weir, two separate outlet works and storage capacity for both flood control and water supply.

At spillway crest, Littleville Reservoir has a total capacity of 32,400 acre-feet of which 23,000 are for flood control. The flood control storage is equivalent to 8.3 inches of runoff from the contributing drainage area of 52.3 square miles. When filled to spillway crest, the reservoir will extend upstream along the Middle Branch for a distance of approximately 3.7 miles, having a surface area of 510 acres. The water supply pool has a surface area of 275 acres.

The dam embankment, about 1,360 feet in length and maximum height of 164 feet above streambed, consists of rolled earth fill with an impervious core and rock slope protection, and is shown on plates H-9 and H-10. The top of dam, elevation 596 feet msl, provides 15.0 feet of spillway surcharge and 5.0 feet of freeboard. The top width of 25 feet accommodates an 18-foot paved access road and the embankment slopes vary from 1 on 3.0 to 1 on 2.5.

A rolled earth fill dike is located on the left abutment of the dam to close a natural saddle between the left abutment of the spillway and high ground. The dike is 935 feet long with a maximum

height of 46 feet; the top of the dike is at elevation 596. Profiles and cross sections of the dike are also shown on plate H-10.

The spillway consists of a concrete ogee weir located on a bedrock plateau on the left bank and a chute type spillway in a bedrock cut. The weir has a length of 400 feet with a crest elevation 576 feet msl, 7 feet above the approach channel bottom. The discharge channel width varies from 372 feet at the foot of the curved weir to 50 feet at a distance of 440 feet downstream. The total length of the spillway channel is 1,250 feet, with bottom slopes varying from 5 to 21.5 percent. The excavated approach area has a 1 percent slope towards the reservoir. A plan and profile of the spillway is shown on plates H-11 and H-12.

The Littleville project has two separate reservoir outlet works - one for water supply releases and the other for flood control releases.

The flood control outlet works consist of an intake channel, gates, tower and outlet tunnel. The intake channel is 20-feet wide, excavated in rock to elevation 515 feet msl. Near the intake structure the channel widens to accommodate a 30-foot concrete weir with crest elevation 518 feet msl, which is the bottom of the flood control pool.

From the weir a concrete-lined channel extends 88.5 feet to the gate structure. Flows are regulated by two 4 x 8 foot wide sluice gates, and discharged through a 370-foot long, 8-foot diameter concrete-lined "horseshoe" tunnel. A plan of the flood control outlet works is shown on plate H-13.

The main components of the water supply outlet works consist of a 17.5-foot wide intake channel with invert at elevation 432 feet msl, an intake structure consisting of a wet well tower with four 36-inch diameter sluice gates at different elevations so that water can be drawn from various levels, an outlet conduit and a 20-foot wide outlet channel. The outlet consists of a 48-inch diameter concrete conduit installed within a 9-foot wide arch-shaped conduit 800 feet in length which was originally used for diversion of the Middle Branch during construction of Littleville Dam.

A plan of the water supply outlet works is shown on plate H-14, and a detailed discussion of the Littleville water supply is included in Attachment A.

3. HISTORY OF PROJECTS

a. Authorization. Knightville Dam and Reservoir was authorized as a project for the Westfield River watershed in the Flood Control Act of 28 June 1938 (Public Law 761, 75th Congress) and set forth in House Document 455, 75th Congress, 2nd session.

Littleville Dam and Reservoir was authorized by the Flood Control Act of 3 July 1958 (Public Law 85-500, 85th Congress) in accordance with recommendations set forth in Senate Document 17, 85th Congress. Inclusion of provisions for future water supply in the Littleville flood control reservoir was authorized under the Water Supply Act of 1958, Public Law 85-55, dated July 3, 1958.

b. Construction. Construction on Knightville Dam was initiated in September 1939 and completed in December 1941. Construction on Littleville Lake was initiated in July 1962 and completed in October 1965.

c. Other Corps of Engineers Projects. The West Springfield Local Protection Project, shown on plate H-15, provides flood protection to the city of West Springfield at the confluence of the Westfield and Connecticut Rivers for a design flood of 405,000 cfs, about 50 percent greater than the 1936 flood of record. Protection is provided on the Westfield to prevent damage from the backwater effect on the Connecticut River. Work by the Corps of Engineers on this project was initiated in 1937 under provisions of the Emergency Relief Appropriation Act of 22 June 1936. Completion of the project was accomplished in stages, the latest improvement being in 1953. The West Springfield dike begins 2 miles north of the mouth of the Westfield River on the west bank of the Connecticut River. From this point the project runs south to the Westfield River and then westerly and northerly on the north bank of the Westfield River for about 3 miles.

Features of the project are listed below:

4,800 linear feet of concrete floodwalls
1,500 linear feet of earth dike
3 pumping stations
3 stoplog structures
14 drainage structures through walls

Operation and maintenance of the project is performed by the city of West Springfield and the periodic inspection of the project is the responsibility of the Littleville Project Manager.

d. Soil Conservation Service Projects

(1) General. The Soil Conservation Service (SCS) of the U.S. Department of Agriculture has constructed flood protection projects throughout New England and in the Connecticut River basin. These projects, authorized by the Watershed Protection and Flood Prevention Act, Public Law 566, are associated with small watersheds up to 250,000 acres in area. Water impoundments under the act are limited to 12,500 acre-feet of flood storage and 25,000 acre-feet total storage.

SCS impoundment structures are regulated by an ungated principal spillway which is essentially an overflow weir, as shown on plate H-16. The spillway, located in the outlet structure, is generally designed so that its outflow combined with flood storage will control all events up to and including the 100-year storm. Storms in excess of this will activate an emergency spillway. This is generally a grassed earth spillway built at one or both ends of the dam and discharging downstream from the toe of the retarding structure.

In the Westfield River watershed, the SCS has constructed or has prepared work plans for several flood protection works. Pertinent data for these projects is listed in table H-1. In general, the three existing SCS projects in the Westfield have no appreciable effect on floodflows on the main stem. With the addition of the 11 projects currently proposed for construction in the West Branch watershed, about 33 of the 96 square miles of the total West Branch drainage area will be controlled.

SCS estimates that these proposed projects will reduce the 100-year frequency flood stage by 2.3 feet at the mouth of the West Branch at Huntington. SCS also anticipates that these projects will reduce flood stages along the main stem from Huntington to Westfield.

(2) Bradlee Brook. The Black Brook project in the Bradlee Brook watershed, shown on plate H-3, is a multipurpose reservoir with a permanent water supply pool. Channel improvement is also scheduled on Bradlee Brook.

TABLE H-1

WESTFIELD RIVER WATERSHED
SOIL CONSERVATION SERVICE
WATER IMPOUNDING STRUCTURES

Project	Drainage Area (sq.mi.)	Flood Control Storage		Principal Spillway Max. Discharge Capacity		Emergency Spillway Design Capacity		Storage Purpose*
		Acre/Feet	Inches	CFS	CSM	CFS	CSM	
Bradlee Brook Watershed								
Black Brook (Nov 1971)	2.8	864	5.8	243	87	10,600	3,790	S,F,W
Powdermill Brook Watershed								
Arm (Oct 1963)	3.4	581	3.3	271	80	5,540	1,630	S,F,R
Powdermill (Aug 1965)	4.6	966	4.0	330	72	7,900	1,720	S,F
Total	8.0	1,712						
West Branch Westfield River Watershed**								
Blandford	0.8	246	5.8	30	38			S,F
Brooker	2.4	643	5.0	206	86			S,F
Cherry	2.4	631	4.9	120	50			S,F,R
Coles	1.4	417	5.6	162	116			S,F,R
Cushman	1.0	315	5.9	30	30			S,F,R
Factory	4.0	1,257	5.9	320	80			S,F,R
Rudd	2.3	579	4.7	125	54			S,F,R
Shaker	3.6	1,139	5.9	90	25			S,F,R
Upper Coles	2.9	1,187	7.7	136	47			S,F,R
Upper Factory	3.9	1,107	5.3	145	37			S,F,R
Walker	8.7	2,110	4.6	530	61			S,F,R
Total	33.4	9,631						

* S-Sedimentation, F-Floodwater, W-Water Supply, R-Recreation
** Awaiting completion of detailed Environmental Impact Statement

(3) Powdermill Brook. This project consists of two floodwater retarding structures - one on Powdermill Brook and the other on Arm Brook. The structure on Arm Brook is a multipurpose reservoir, providing storage for fish and wildlife enhancement as well as floodwaters. Locations of these two projects are shown on plate H-3.

(4) West Branch. Construction is scheduled for 11 flood retarding structures and a channel improvement project on the West Branch, pending conclusion of a detailed Environmental Impact Statement. Also included in the plan is additional storage in 9 reservoirs for recreation and for fish and wildlife use. Plate H-17 indicates the proposed locations of the structures in the West Branch watershed.

e. Non-Federal Projects

(1) Cobble Mountain Reservoir. Cobble Mountain Reservoir (see plate H-18), located on the Westfield Little River, controls the upper 45.5 square miles of drainage area. The dam and reservoir is owned and operated by the Springfield Water Department for water supply and hydropower. However, reservoir releases are coordinated with the Western Massachusetts Electric Company for the generation of power.

Pertinent data for Cobble Mountain Dam and Reservoir is briefly summarized:

Date of Construction:	1928-1932
Type of Construction:	Hydraulic earthfill
Storage Capacity:	70,000 acre-feet
(Usable):	64,000 acre-feet
Spillway Capacity:	24,000 cfs with 10-foot freeboard
Outlet Capacity:	1,000 cfs

(2) Private Dams and Reservoirs. The four private dams between the projects and the city of Westfield have little effect on stages on the Westfield River and, hence, have little influence on flood control regulation. Pertinent data for these four projects are listed in table H-2.

TABLE H-2

WESTFIELD RIVER
PRIVATE DAMS AND RESERVOIRS

Project Name	Crescent Mills	---	Woronoco Mills I	Woronoco Mills II
Drainage Area (sq.mi.)	329	344	354	354
Date Constructed	1850	1865	1939	1950
Type	stone and concrete gravity	concrete gravity	stone and concrete gravity	stone and concrete gravity
Structural Features				
Dam Height (ft)	56	36	29	60
Dam Width (ft)	270	449	322	351
Spillway Width (ft)	210	377	307	345
Freeboard (ft)	9	6	4	10
Storage (acre-feet)				
Normal	3,200	620	480	1,350
Maximum	6,440	720	960	1,420
Purpose	process water	process water	hydropower	hydropower
Project Owner	Texon Paper Co.	Westfield River Paper Co.	Strathmore Paper Co.	Strathmore Paper Co.

f. Modification to Authorization. There have been no modifications to the authorized projects at either Knightville Dam or Littleville Lake.

g. Previous Reports. House Document 455, 75th Congress, 2nd Session, contains a report on survey and comprehensive plan for flood control in the Connecticut River Valley, dated 29 March 1937. Knightville Dam and the West Springfield Local Protection Project were included with the 20 reservoirs in the comprehensive plan, which also recommended dikes at seven cities. This report was prepared by the Corps of Engineers.

An interim report, dated 29 January 1940, and printed as House Document 653, 76th Congress, 3rd Session, considered revision of authorized local protection works at seven localities, including West Springfield along the Westfield and Connecticut Rivers. This report recommended the authorized plan be modified to provide for construction at the local works in accordance with revised plans. The plan was authorized by Public Law 228, 77th Congress, approved 18 August 1941.

A "Review of Reports on Surveys of the Connecticut River and Tributaries for Flood Control," dated 28 February 1940 and revised 18 December 1944, was prepared by the Corps of Engineers. Knightville Dam was included among the 29 reservoirs of the revised comprehensive plan presented in this report.

Flood control and allied water uses in the Westfield River watershed were discussed in part 2, Chapter XXI, Connecticut River Basin, of "The Resources of the New England-New York Region," a comprehensive survey of the land, water and related resources of this region. The report, prepared by the New England-New York Interagency Committee, was submitted to the President of the United States by the Secretary of the Army on 27 April 1956. The flood control plan set forth in this report included two flood control reservoirs in the Westfield River watershed; namely, Knightville and Littleville. Part I and Chapter I of Part 2 are printed as Senate Document 14, 85th Congress, 1st Session.

The Corps of Engineers report, "New England Basins, Report on Flood Control and Allied Purposes," dated 30 June 1955, presented a comprehensive flood control plan for the Connecticut

River basin essentially the same as that given in the NENYIAC Report.

An interim report, dated 30 April 1956 and printed as Senate Document 17, 85th Congress, 1st Session, reviewed the need for additional flood control reservoirs in the Westfield River watershed and recommended that the authorized plan for flood control in the Connecticut River basin be revised to include Littleville Dam and Reservoir on the Middle Branch of the Westfield River. This project was authorized by the Flood Control Act of 1958, Public Law 85-500, 85th Congress, approved 3 July 1958.

An interim report, dated 6 November 1959 and printed as Senate Document 109, 86th Congress, 2nd Session, again reviewed the flood problems of the Westfield River watershed and recommended the authorized plan for flood control in the Connecticut River basin be revised to include the Westfield Local Protection Project.

The Comprehensive Water and Related Land Resources Investigation in June 1970 recommended a basinwide flood control plan which included structural measures to be prepared by the Corps of Engineers and the Soil Conservation Service. Structural measures recommended for the Westfield River watershed by the Corps of Engineers, namely, the Westfield LPP and a seasonal recreational pool at Knightville Dam are briefly summarized:

(1) The Westfield LPP, as proposed, would protect 2,700 acres in Westfield, Massachusetts and would consist of 5,000 feet of floodwalls and 43,000 feet of earth dike along the main stem of the Westfield and the Westfield Little Rivers and Powder Mill Brook. In addition, the project would also include 6,000 feet of overflow channel on the Westfield Little and Westfield Rivers, two pumping stations, six street gates, one railroad gate and a small length of channel realignment on Powder Mill Brook.

(2) A recreational pool at Knightville was proposed, to be established after the spring runoff and maintained at elevation 538 feet msl (stage 58 feet) with a water surface area of 275 acres. This pool would utilize 6,000 acre-feet or 0.7 inch of storage (about 13 percent of the total storage capacity of the reservoir). This proposal was not implemented due to state and local opposition.

h. Flood Plain Information Reports

(1) General. These reports analyze topographic features and hydrologic history to determine flood potential (i.e., flood plain delineations and frequency of flood stages and discharges). This information, where determined, is available to planning groups, zoning boards, private citizens, real estate or industrial developers and others to determine the wise uses of a flood plain.

(2) Westfield. A Flood Plain Information Report entitled: "Westfield and Little Rivers - Westfield, Massachusetts," authorized under Section 206 of the Flood Control Act of 1960 (Public Law 86-645), was prepared at the request of the city of Westfield by the New England Division in June 1969.

i. Flood Insurance Studies. These studies, carried out under provision of the National Flood Insurance Act of 1968 (Public Law 90-448, Title XIII), map communities eligible for the Flood Insurance Program by risk zones and determine insurance rates. Administration of this program is handled by the Department of Housing and Urban Development which utilizes services of the private insurance industry with Federal subsidization to provide flood insurance to family dwellings and small business properties and their contents.

As of June 1977, communities in the Westfield River watershed which have instituted flood plain zoning to some degree in accordance with this plan are Cummington on the Westfield River and Hinsdale on the West Branch Westfield River.

j. Principal Project Problems. There have been no major problems with the structure or the reservoir area at Knightville Dam.

In October 1966, leakage in 4 of the 5 water supply gates occurred at Littleville Lake. This leakage was reduced to a negligible amount by readjustment of the gate seals. Another problem occurring at this time was damage to one of the water supply gates, which was the result of gate #1 failing to stop after closure. Repair of the gate was completed and the limit switch of the motor was also replaced in order to prevent a recurrence.

In May 1972, the flood control gates of Littleville were discovered to be operating very noisily, with some vibrations during

closing cycles when the pool stages reached 528 to 533 feet msl. Following recommendations of the gate manufacturers, the vibration noise problem was not considered serious - no action has been taken.

k. Current Studies (1977)

(1) Westfield Local Protection Project. The necessity of the project was brought about by extensive development of areas in Westfield subject to flooding. Originally, the project was authorized in July of 1960, but failed to win voter approval in the November 1965 election. As a result, authorization for the project was allowed to expire.

Interest in this project was renewed however, and authorization restored with publication of the Comprehensive Water and Related Land Resources Investigation: Connecticut River Basin. This study, submitted to the U.S. Congress in June 1970, urged the completion of this project with the inclusion of dikes and floodwalls to protect the left bank of the Westfield River.

Current plans call for construction of dikes and floodwalls to protect the city of Westfield - about 14,000 feet along the left bank of the Little River, 19,000 feet on the right bank of the Westfield River above the confluence with the Little River, 6,800 feet on the left bank of the Westfield River upstream of Powder Mill Brook and 7,200 feet on the right bank of Powdermill Brook. The plans also call for channel realignment of both the Westfield and Little Rivers and construction of pumping stations and appurtenant structures.

Plate H-19 indicates the proposed general plan as of August 1977 for the Westfield Local Protection Project.

(2) Modification to Knightville Dam. Pursuant to the authority contained in Engineer Circular 1110-2-34, dated 1 November 1966, Review of Design Features of Existing Dams, a review was completed in March 1968 of all reservoirs in the New England Division. The purpose of this hydrologic review was to determine whether existing projects conformed adequately with current policies and criteria with respect to safety and functional reliability. This study concluded that additional freeboard was necessary at Knightville Dam.

As a result of this finding, additional studies were made of

Knightville, and a report, Hydrologic Review of Spillway and Storage Capabilities of Knightville Dam, was prepared in September 1975. This report determined that an additional 2.3 feet of freeboard was required to bring Knightville up to current hydrologic design criteria.

Another aspect relative to current criteria in the Knightville design is the limited amount of flood control storage. A study has been conducted which considered structural measures for adding various amounts of storage. However, structural modification to increase freeboard and provide additional storage could not be economically justified, and only stabilization of the spillway was recommended.

(3) Modification to West Springfield Local Protection Project. This study is authorized under Section 216 of Public Law 91-611, dated 31 December 1970. Studies and evaluations are currently being conducted to determine whether this existing project conforms adequately with current policies and criteria with respect to safety and functional reliabilities. Results from the study are expected during FY 1979.

4. ECONOMY OF THE WATERSHED

a. General. The Westfield River watershed encompasses, either wholly or partially, approximately 30 communities in western Massachusetts. Most of these communities have population densities less than 100 people per square mile. The northern portion of the watershed is primarily rural and sparsely populated. More concentrated population centers lie in the southern portion of the watershed, including the cities of Westfield, West Springfield, Holyoke, and the town of Agawam.

Early development within the watershed occurred in the mid-1700's. During this time numerous rivers and streams in the watershed saw the development of many grist, saw and paper mills and tanneries. However, due to the rugged terrain throughout the region, expansion of industry was limited to the southeastern portion of the watershed, hence northern communities concentrated on agricultural activities.

b. Population. Holyoke, with a population of 50,112 in 1970, is the most populated of the communities within the watershed. Following are Westfield with a population of 31,433, West Springfield with 28,461, and Agawam with 21,717. These are the only

communities in the watershed with populations over 10,000. For the 20-year period from 1950 to 1970, Westfield, West Springfield and Agawam experienced a population growth of 4, 30 and 113 percent, respectively, while Holyoke experienced a loss of 8 percent. Most of the remaining communities showed population increases.

c. Present Economy. Many residents living in the northern portion of the watershed are still engaged in agricultural activities. However, others from these areas commute to jobs in larger population centers such as Pittsfield and Springfield.

Between 1960 and 1970, Westfield, West Springfield and Agawam showed increases in total employment of 24, 26 and 52 percent, respectively, while Holyoke experienced a decline of 7 percent. Although manufacturing is still the largest employer in these areas, according to 1970 census data, the overall employment of manufacturing as well as agriculture has decreased throughout the watershed. Increases in employment were experienced in the services, finance, insurance and real estate sectors.

CHAPTER II

MANAGEMENT

5. GENERAL

a. Project Owner. Both Knightville Dam and Littleville Lake are owned by the New England Division, Corps of Engineers.

b. Operating Agency. The New England Division is responsible for the operation and regulation of both projects. Staffing on a normal work week, Monday through Friday, is 0800 to 1630 hours, and from 0800 to 0900 on Saturday, Sunday and holidays, with the Project Managers living on site. During flood emergency conditions, the projects will be staffed on a 24-hour basis or as instructed by RCC.

Management and operation of water supply facilities at Littleville Lake are the responsibilities of the New England Division. However, future water supply releases from the project will be coordinated with the Springfield Water Engineer and Board of Water Commissioners. A copy of the agreement between the Corps and the city of Springfield is contained in Attachment A.

6. FUNCTIONAL RESPONSIBILITIES

a. Corps of Engineers. The reservoir regulation activities are performed by the Reservoir Control Center (RCC), whose responsibilities are spelled out in a publication entitled: "Guidance Memorandum, Reservoir Control Center," dated September 1971. RCC is an element of the Water Control Branch within the Engineering Division. Administrative and maintenance activities at Knightville and Littleville are performed by Project Managers under supervision of the Reservoir Branch of the Operations Division. This supervision is facilitated by the Lower Connecticut River Basin Manager who oversees the operation and maintenance activities at Corps reservoirs in the lower basin. However, during regulation periods the Project Managers report directly to RCC for regulation instructions and information.

The Water Control Branch is comprised of three sections,

namely, Reservoir Control Center, Hydrologic Engineering, and Hydraulics and Water Quality. RCC consists of a staff of highly trained hydraulic engineers who devote full time to the regulation of reservoirs in New England. Members of the other sections not only assist the RCC during routine and flood operations, but also provide technical assistance to the Center as needed. An organization chart for reservoir regulation in the New England Division is shown on plate H-20.

RCC is divided into basin units, each responsible for receiving routine hydrologic and meteorologic reports and directing reservoir regulation within an assigned river basin. Personnel from RCC and other sections of the Water Control Branch are assigned to these units. Each unit consists of a regulator in charge of the overall operation in the basin, and project regulators who receive reports and issue instructions to individual dams either from NED headquarters during working hours or from their homes during non-working hours. Whenever severe emergency conditions exist, RCC staffs NED headquarters and regulation units are organized to assure 24-hour operations as long as necessary.

b. Other Agencies. There are no other Federal, State, County or private agencies that have any responsibility in regulating the flood control aspect of either Knightville Dam or Littleville Lake.

7. INTERAGENCY COORDINATION

a. Interagency Agreements. The Corps of Engineers has cooperative working programs with the U.S. Geological Survey, the National Weather Service and its Northeast River Forecast Center at Bloomfield, Connecticut. The Corps uses the hydrologic and forecasting information from these agencies as an added guide in regulating its flood control reservoirs in an efficient manner to provide protection for all downstream communities.

b. Compacts. Congress, by the passage of Public Law 52, 83rd Congress, 6 June 1953, granted its consent and approval to an interstate compact, covering the Connecticut River Valley, that had been previously ratified by the States of New Hampshire, Vermont, Massachusetts and Connecticut. The principal purposes of the compact are:

(1) Assuring adequate storage capacity for impounding waters

of the basin in the interest of flood control. Five dams - Union Village, Surry Mountain, Knightville, Tully and Birch Hill were in operation at the time the compact was instituted. These dams were endorsed by the compact and included in the tax sharing clause. Twelve additional locations were agreed upon for future tax reimbursement if constructed.

(2) A system of tax loss reimbursement was set up so that the States in the Southern Connecticut River basin would share the tax loss with the Northern States from Federal acquisition of lands for any flood control dam and reservoir built in the Connecticut River Valley. A tabulation of this tax reimbursement is listed below:

Recipient State	Percent Tax Loss Reimbursed	Reimbursing State
Vermont	40	Connecticut
Vermont	50	Massachusetts
New Hampshire	40	Connecticut
New Hampshire	50	Massachusetts
Massachusetts	40	Connecticut

(3) Providing a joint or common agency through which the signatory States may effectively cooperate in accomplishing the objectives of flood control and water resources utilization in the basin.

The compact also provides for creation of a commission consisting of three representatives from each State with authority to enter into contracts and agreements and to make such ongoing studies and investigations as may be required in the interest of flood control and in cooperation with Federal agencies.

c. News Releases. It is the policy of the Corps of Engineers to cooperate with the local press and all other forms of news media. This cooperation provides the local community with information regarding the regulation of the Westfield River projects.

The primary source of information regarding the regulation of the projects is the Public Affairs Officer who is responsible for issuing all communiques to the press and news media.

Whenever Project Managers receive requests for information

from local news media and/or private citizens, the manager can relate information pertinent to his project; however, he will not make any flood forecasts. Referrals should be made to RCC or the National Weather Service for additional information.

CHAPTER III

HYDROMETEOROLOGY

8. DESCRIPTION OF WATERSHED

The Westfield River watershed, the fifth largest in the Connecticut River basin, covers a large portion of the eastern slopes of the Berkshires in western Massachusetts. The basin is located within the confines of Berkshire, Franklin, Hampden and Hampshire Counties, with a small portion extending into Hartford County, Connecticut. The watershed has an approximate length of 48 miles in a north-south direction, an average width of about 11 miles and a total drainage area of 517 square miles. Elevation of the watershed varies from 2,505 feet msl at Borden Mountain in the headwaters to about 40 feet msl at the confluence with the Connecticut River in Agawam and West Springfield, Massachusetts. Topography of the upper portion of the Westfield River basin, above the city of Westfield, is rough and rocky and is drained by many small streams which are conducive to rapid runoff. About 2 miles downstream of Westfield the flood plain is bisected by a row of hills, Provin and East Mountains, which are a section of the Holyoke range.

The Westfield River rises in Savoy, Hampshire County, Massachusetts at an elevation in excess of 2,000 feet above mean sea level. The river follows a generally southeasterly course for about 57 miles, joining the Connecticut River between West Springfield and Agawam, opposite the western limits of the city of Springfield and about 75 miles above Long Island Sound. The Westfield River has a total fall of about 2,000 feet. Profiles of the river and its principal tributaries are shown on plate H-21.

The five principal tributaries of the Westfield River are the Westfield Little River, Powdermill Brook, Great Brook, the Middle Branch and the West Branch.

Westfield Little River has its source at Cobble Mountain Reservoir, a water supply and hydroelectric power reservoir in Blandford and Granville. From its source the river flows in an easterly direction for about 12 miles to its confluence with the Westfield River in Westfield. It has a total drainage area of 84.9

square miles and a total fall of about 830 feet. Approximately 45.5 square miles of drainage area is controlled by Cobble Mountain Reservoir.

Great Brook, originating at Congamond Lakes at Congamond, Massachusetts, flows in a northerly direction to the Westfield River in Westfield. Total drainage area of the brook is 30.2 square miles and the total fall in river miles is about 120 feet.

Powdermill Brook, originating in Westfield, Massachusetts, flows in a southwesterly direction for approximately 9 miles. Total area of the brook is about 20.1 square miles and the brook falls a total of about 830 feet from its headwater to its confluence with the Westfield River in Westfield.

Middle Branch Westfield River, originating at the Peru-Worthington town line in northwest Worthington, flows in a southeasterly direction for about 16 miles to its confluence with the Westfield River at Goss Heights in Huntington. It has a drainage area of 53 square miles and a fall of about 1,140 feet.

West Branch Westfield River has its origin in Becket and flows in a southeast direction for about 17 miles to its confluence with the Westfield River in the southwest corner of Huntington. It has an area of 96 square miles and a fall of about 860 feet.

9. CLIMATE AND RUNOFF

a. General. The Westfield River watershed has a variable climate, with the lower basin relatively mild and typical of the lower Connecticut River Valley while the upper watershed has a more severe climate due to its rough topography and higher elevation. The temperature ranges from a summertime high in the nineties to subzero periods in the winter. In the upper basin, snow covers the ground from December until the spring melting season in March and April.

b. Temperature. The mean annual temperature varies from about 44° Fahrenheit in the mountainous regions to about 50 degrees in the valleys. Recorded temperature extremes at representative stations within or adjacent to the watershed have varied from a maximum of 102° Fahrenheit in the lower elevations to a minimum of -30 degrees in the headwaters. Freezing temperatures may

occur from September until late May. Table H-3 shows the mean monthly, maximum and minimum temperatures at Knightville Dam in the Westfield River watershed, and at Stockbridge and Springfield which are in the vicinity of the watershed.

c. Precipitation. The average annual precipitation over the watershed is approximately 46 inches, uniformly distributed throughout the year. Table H-4 summarizes the monthly precipitation at Peru, Knightville Dam, Chester and Westfield, Massachusetts through 1975. Plate H-22 tabulates the annual precipitation for these stations.

d. Snow and Snow Cover. The average monthly snowfall at Knightville Dam, Chesterfield, West Otis and Springfield are shown in table H-5. Chesterfield and West Otis can be considered representative of the headwater region of the watershed. Knightville Dam is typical of the area around the projects, and Springfield is indicative of the lower portion of the watershed.

Snow surveys have been taken by the Corps of Engineers in the upper Westfield River watershed since 1950. These surveys are taken to determine the water equivalence and density of snow cover and hence the runoff potential of the watershed due to snowmelt. The Project Managers relay this data to RCC, where it is analyzed with similar information from other basins. A weekly snow bulletin is prepared from the end of January through the end of the snowmelt period in April.

Water content of the snow in the Westfield River watershed normally reaches a maximum in the middle of March. The recorded mean, maximum, and minimum average basin water content of the snow in March are 4.0, 9.5 and zero inches, respectively. Plate H-23 shows the mean, maximum and minimum as presented in the bulletins, and pertinent data on the snow course stations in the watershed are shown in table H-6.

e. Storms. The Westfield River watershed has experienced storms of four general types, namely:

(1) Extratropical continental storms which move across the basin under the influence of the "prevailing westerlies".

(2) Extratropical maritime storms which originate and

TABLE H-3

MONTHLY TEMPERATURES
(Degrees Fahrenheit)

Month	Springfield, Mass. Elev. - 190 ft, msl (1904-1975)			Knightville Dam, Mass. Elev. - 630 ft, msl (1949-1976)			Stockbridge, Mass. Elev. - 820 ft, msl (1932-1975)		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
January	26.8	68	-18	21.4	60	-24	22.5	65	-29
February	27.8	74	-18	23.2	63	-24	23.4	63	-28
March	36.7	87	-11	31.7	69	-14	32.3	82	-17
April	48.4	93	10	44.4	84	10	44.1	89	9
May	59.5	97	27	54.8	90	23	55.1	92	24
June	68.4	101	32	64.7	99	32	63.4	92	30
July	73.3	104	30	69.2	99	40	67.8	97	37
August	71.5	102	39	66.8	100	38	65.8	93	32
September	63.7	102	26	58.9	100	24	58.7	91	24
October	53.5	90	20	48.8	88	17	49.0	87	12
November	42.2	83	4	37.9	81	2	38.6	79	-8
December	30.5	66	-16	26.1	61	-19	26.6	63	-21
ANNUAL	50.2	104	-18	45.6	100	-24	45.6	97	-29

TABLE H-4

MONTHLY PRECIPITATION
(Depth in Inches)

Month	Westfield, Mass. Elevation 220 feet msl Period of Record-70 yrs (through 1975) Mean	Maximum	Minimum	Knightville Dam, Mass. Elevation 630 feet msl Period of Record-27 yrs (through 1975) Mean	Maximum	Minimum
January	3.08	7.52	0.77	3.08	6.40	0.75
February	3.31	6.75	1.24	3.18	5.11	1.24
March	3.77	9.71	0.27	3.82	10.18	1.28
April	3.96	8.72	0.75	3.68	5.97	0.82
May	3.75	7.08	0.88	3.54	6.73	0.95
June	3.99	10.09	0.39	3.64	9.12	0.57
July	3.83	10.06	0.32	3.39	7.71	1.12
August	4.05	26.85	0.71	3.69	15.27	1.06
September	4.03	12.41	0.24	3.59	8.06	1.38
October	3.50	12.50	0.05	3.46	16.95	0.42
November	4.11	9.79	0.40	4.36	8.11	0.81
December	3.89	8.90	0.60	4.23	9.38	0.65
ANNUAL	45.21	70.33	29.69	43.61	62.36	32.15

Month	Chester, Mass.* Elevation 600 feet msl Period of Record-58 yrs (through 1975) Mean	Maximum	Minimum	Peru, Mass.** Elevation 1860 feet msl Period of Record-36 yrs (through 1969) Mean	Maximum	Minimum
January	3.45	6.83	0.57	3.73	7.31	1.00
February	3.33	5.77	1.26	3.28	6.58	0.93
March	3.92	10.49	0.21	4.16	10.32	1.25
April	3.83	8.37	0.75	3.76	6.43	0.68
May	4.32	9.92	0.79	4.03	7.77	0.92
June	4.45	14.31	0.23	4.33	10.55	1.53
July	4.22	10.16	1.01	4.60	10.88	1.73
August	4.32	18.44	0.54	3.76	14.07	0.78
September	4.08	12.61	0.40	4.66	12.36	0.68
October	3.68	17.51	0.00	3.65	14.37	0.76
November	4.69	11.01	1.00	4.27	8.35	1.27
December	4.14	11.39	0.76	3.93	10.37	1.14
ANNUAL	48.43	76.15	32.23	48.20	65.42	36.15

* Discontinued in 1957, new station located in vicinity of the original station since 1962
** Discontinued in 1969

TABLE H-5

MONTHLY SNOWFALL
(Average Depth in Inches)

Month	Knightville Dam Elev. - 630 ft, msl (1948-1975)	Chesterfield, Mass. Elev. - 1425 ft, msl (1931-1975)	West Otis, Mass. Elev. - 1360 ft, msl (1940-1975)	Springfield, Mass. Elev. - 190 ft, msl (1880-1975)
January	13.1	18.3	14.2	12.7
February	14.5	19.8	16.3	13.8
March	12.2	14.9	13.3	9.4
April	2.8	5.1	4.9	1.7
May	0	0.2	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0.2	0.2	0
November	3.1	5.0	5.4	2.3
December	12.3	12.8	11.4	8.7
ANNUAL	55.9	76.3	65.7	48.6

TABLE H-6

CORPS OF ENGINEERS
SNOW COURSE LOCATIONS
WESTFIELD RIVER WATERSHED

Course (Massachusetts)	Elevation	Latitude	Longitude	Period of Record
Savoy	1,800	42°34'	73°02'	Dec 1948 - to date
Spruce Corner	1,400	42°31'	72°51'	Dec 1948 - to date
Cummington	1,100	42°31'	72°55'	Dec 1948 - Mar 1973
Lithia Post Office	1,180	42°27'	72°50'	Jan 1958 - to date
West Worthington	1,790	42°26'	72°58'	Dec 1948 - to date
West Chesterfield	740	42°21'	72°53'	Dec 1948 - to date
Middlefield	1,670	42°21'	73°01'	Jan 1955 - to date
Chester	720	42°18'	72°59'	Jan 1955 - Mar 1973
Knightville Dam	500	42°18'	72°59'	Dec 1948 - to date

move northward along the eastern coast of the United States.

(3) Storms of tropical origin, some of which attain hurricane magnitude.

(4) Thunderstorms produced by local convective action or by more general frontal activity.

The most severe storms have been of tropical origin which occur during the late summer and early autumn. The six notable recent storms in the Westfield River basin occurred in November 1927, March 1936, September 1938, December 1948, August and October 1955. Of these, the events of November 1927, September 1938, August and October 1955 were of tropical origin. The August 1955 storm, accompanying hurricane "Diane", dumped nearly 20 inches of rain in Westfield in about 48 hours establishing the flood of record for the watershed.

f. Runoff

(1) Discharge Records. There are 8 USGS gaging stations in the watershed (locations are shown on plate H-3). The period of record for these stations is listed on page i at the front of the manual. A daily hydrograph for the Westfield River at Westfield from 1935 to 1961 is shown on plate H-24.

(2) Streamflow Data. Average annual runoff for the 61-year period of record for the gage on the Westfield River at Westfield is 25.7 inches, with a maximum of 44.1 inches in water year 1928, and a minimum of 11.1 in water year 1965. The mean annual runoff represents about 55 percent of the mean annual precipitation and about 50 percent of this runoff occurs in the spring months of March, April and May. Discharges for the period of record have varied from a maximum of 70,300 cfs on 19 August 1955 to a minimum of 9 cfs on 2 October 1921. The minimum average daily flow was 40 cfs on 29 December 1914 and the average annual flow is 940 cfs.

A summary of the maximum, minimum and average monthly and the average annual runoff for selected USGS gaging stations are shown in table H-7. Annual runoff for each station is listed on plate H-25. A summary of runoff data for the stations is also shown on pertinent data sheet i of hydrologic information. Rating

TABLE H-7
MONTHLY RUNOFF
WESTFIELD RIVER WATERSHED

Westfield River
at Knightville, Mass.(1)
(D.A. = 162 sq. mi.)
1909-1974

Month	Average		Maximum		Minimum	
	CFS	Inches	CFS	Inches	CFS	Inches
January	279	2.0	1305	4.8	46	0.3
February	260	1.7	667	4.3	65	0.4
March	614	4.4	2050	14.6	158	1.1
April	923	6.4	1757	12.1	302	2.1
May	433	3.1	910	6.5	166	1.2
June	231	1.6	829	5.7	41	0.3
July	122	0.9	479	3.4	21	0.2
August	98	0.7	745	5.3	16	0.1
September	115	0.8	986	6.8	16	0.1
October	153	1.1	1394	10.8	18	0.1
November	288	2.0	1155	7.1	39	0.3
December	307	2.2	1033	7.4	69	0.5
Water Year	321	26.9	537	45.1	137	11.5

Middle Branch Westfield River
at Goss Heights, Mass.(2)
(D.A. = 52.6 sq. mi.)
1910-1974

Month	Average		Maximum		Minimum	
	CFS	Inches	CFS	Inches	CFS	Inches
January	95	2.1	213	4.7	15	0.3
February	85	1.7	239	4.7	17	0.4
March	208	4.6	653	14.3	60	1.3
April	290	6.2	594	12.6	85	1.8
May	132	2.9	280	6.1	41	0.9
June	66	1.4	351	7.4	4	0.1
July	32	0.7	150	3.3	5	0.1
August	27	0.6	316	6.9	3	0.1
September	32	0.7	328	7.0	1	0.1
October	51	1.1	507	11.1	4	0.1
November	98	2.1	366	7.8	9	0.2
December	108	2.4	351	7.7	18	0.4
Water Year	103	26.5	182	47.1	43	11.0

West Branch Westfield River
at Huntington, Mass.
(D.A. = 93.7 sq. mi.)
1935-1974

Month	Average		Maximum		Minimum	
	CFS	Inches	CFS	Inches	CFS	Inches
January	170	2.1	404	5.0	49	0.6
February	168	1.9	371	4.2	44	0.5
March	347	4.3	1089	13.5	121	1.5
April	508	6.1	1067	12.8	158	1.9
May	234	3.0	452	5.6	81	1.0
June	133	1.6	684	8.2	25	0.3
July	65	0.8	307	3.8	8	0.1
August	56	0.7	630	7.8	8	0.1
September	58	0.7	575	6.9	9	0.1
October	97	1.2	1033	12.8	16	0.2
November	167	2.0	542	6.5	25	0.3
December	202	2.5	662	8.2	40	0.5
Water Year	182	27.0	287	41.7	74	10.7

Westfield River(3)
at Westfield, Mass.
(D.A. = 497 sq. mi.)
1914-1974

Month	Average		Maximum		Minimum	
	CFS	Inches	CFS	Inches	CFS	Inches
January	840	2.0	2211	5.2	196	0.5
February	812	1.8	1761	3.9	234	0.5
March	1700	4.1	5515	12.9	618	1.5
April	2405	5.5	4908	11.1	855	1.9
May	1233	2.9	2465	5.7	458	1.1
June	693	1.6	1926	4.4	181	0.4
July	432	1.0	1600	3.7	114	0.3
August	340	0.8	3393	7.9	83	0.2
September	380	0.9	2941	6.7	89	0.2
October	439	1.1	4879	11.4	103	0.2
November	846	2.0	3384	7.7	202	0.5
December	934	2.2	2174	5.1	220	0.5
Water Year	941	25.7	1590	44.1	368	11.09

(1) Adjusted for change in storage in Knightville Reservoir since 1943
(2) Adjusted for change in storage in Littleville Reservoir since 1965
(3) Adjusted for change in storage in Knightville and Littleville

tables for the USGS gages at Westfield, Huntington, Goss Heights, Knightville and several points along the Connecticut River are shown on plates H-26 through H-34.

g. Frequency Analysis

(1) Peak Discharge Frequency. The natural frequency of occurrence of discharges for selected USGS gaging stations in the Westfield River watershed is shown in table H-8. Frequency analysis was made in accordance with procedures in ER 1110-2-1450, "Hydrologic Frequency Estimates," dated 10 October 1962. Following a regional frequency analysis, a skew coefficient of 1.0 was adopted for all tributaries of the Connecticut River. The following discharge frequency data was prepared for the "Comprehensive Water and Related Land Resources, Connecticut River Basin" in June 1970, and it includes only that data collected through 1963.

TABLE H-8

NATURAL PEAK DISCHARGE
FREQUENCY DATA
(In cfs)

Expected Probability Percent Change	Years	Westfield River at Westfield	West Branch at Huntington	Middle Branch at Goss Heights
0.50	200	127,000	35,500	27,000
1.00	100	95,000	27,000	20,000
2.00	50	70,500	20,000	14,500
4.00	25	52,000	14,700	10,900
5.00	20	47,500	13,300	9,500
10.00	10	34,500	9,700	6,900
20.00	5	25,000	6,900	4,900
50.00	2	16,300	4,650	3,350
99.00	1±	11,400	3,350	2,400

(2) Frequency of Reservoir Filling. The pool stage at Knightville Dam has equalled or exceeded 65 feet, approximately

13 percent of flood control storage capacity, about 38 times from the beginning of operations in December 1941 through July 1977. The pool stage at Littleville Lake has equalled or exceeded 526 feet msl, approximately 10 percent of flood control storage capacity, about 14 times from the beginning of operations in October 1965 through July 1977. A tabulation of these operations, with the amount of floodwaters stored, is presented in tables H-9 and H-10. Area-capacity table and area-capacity and percent full curves are shown on plates H-35 through H-37 for Knightville Dam and on plates H-38 through H-40 for Littleville Lake.

10. CHANNEL AND FLOODWAY

The nondamaging channel capacity downstream of Knightville Dam is approximately 4,500 cfs and about 1,700 cfs below Littleville Lake on the Middle Branch of the Westfield River. Releases bringing downstream flows up to nondamaging channel capacity should be made at Knightville and Littleville during phase III regulation provided releases do not exceed peak inflow into the reservoir.

Principal damage centers in the Westfield watershed are Westfield and West Springfield. Key index stations in the Westfield watershed include the gaging stations at Westfield and at Huntington. Gaging stations on the Connecticut River at Montague City, Springfield and Hartford are monitored during flood control regulation.

The limiting influence on discharges from Knightville and Littleville is the flood plain in the heavily populated city of Westfield. A stage of 14 feet (13,000 cfs) at the Westfield gaging station is considered to be the nondamaging channel capacity.

11. FLOODS OF RECORD

a. General. Flooding in the watershed can occur at any time of the year. The floods of November 1927, September 1938, August 1955 and October 1955 were caused by heavy rainfall, while the events of March 1936 and April 1960 were caused by heavy precipitation, warm weather and considerable snowmelt.

b. Historic Floods. Damaging floods have occurred along the Westfield River and its tributaries since founding of the first settlement in the watershed. Information regarding the most severe flooding in this area was obtained through field investigations and

TABLE II-9

SIGNIFICANT STORAGES
AT KNIGHTVILLE DAM

Date	Maximum Stage	Storage Utilized		
		Inches	Acre-Feet	Percent
May 1943	73.0	1.3	11,000	22
Nov 1943	77.0	1.5	12,700	26
Jun 1944	80.8	1.7	14,400	29
Apr 1945	78.0	1.5	13,000	27
Jun 1945	78.0	1.5	13,000	27
Apr 1947	67.0	1.0	8,800	18
Mar 1948	99.2	2.9	24,500	50
Jan 1949	130.2	5.7	49,400	100+
Nov 1950	65.8	1.0	8,350	18
Apr 1951	94.7	2.6	21,800	44
Apr 1952	83.0	1.8	15,600	31
Jun 1952	86.8	2.0	17,400	35
Dec 1952	66.0	1.0	8,450	17
Mar 1953	112.2	4.0	34,000	68
Sep 1954	66.9	1.0	8,700	18
Nov 1954	63.2	0.9	7,450	15
Aug 1955	105.0	3.3	28,500	57
Oct 1955	127.8	5.5	47,200	96
Nov 1955	79.5	1.6	13,800	28
May 1956	83.9	1.9	16,000	32
Apr 1958	67.2	1.1	8,900	18
Apr 1959	65.6	1.0	8,300	17
Oct 1959	70.4	1.2	10,000	21
Apr 1960	107.0	3.5	29,800	60
Apr 1962	79.7	1.6	14,000	28
Apr 1967	75.4	1.4	12,100	24
Mar 1968	75.7	1.4	12,100	25
Apr 1969	89.0	2.1	18,600	38
Apr 1970	65.0	1.0	8,100	17
Apr 1972	69.4	1.1	9,550	20
Mar 1973	67.5	1.1	9,000	18
Jul 1973	71.1	1.2	10,200	21
Dec 1973	83.9	1.8	15,700	32
Mar 1975	70.0	1.1	9,760	20
Sept 1975	71.7	1.2	10,200	21
Jan 1976	65.8	1.0	8,400	17
Apr 1976	76.2	1.4	12,300	25
Mar 1977	94.7	2.5	21,800	44

Zero stage = 480 feet msl

TABLE H-10

SIGNIFICANT STORAGES
AT LITTLEVILLE LAKE

Date	Maximum Elevation	Storage Utilized		
		Inches	Acre-Feet	Percent
Apr 1967	531.4	1.6	4,300	18
Mar 1968	534.0	1.9	5,200	22
Apr 1969	540.7	2.7	7,600	33
Apr 1970	529.0	1.3	3,600	16
Apr 1972	536.3	2.2	6,000	26
Jun 1972	533.7	1.8	5,000	22
Jul 1972	530.5	1.5	4,100	17
Mar 1973	531.4	1.6	4,300	18
Jul 1973	530.8	1.5	4,200	18
Dec 1973	538.1	2.4	6,600	28
Mar 1975	532.6	1.7	4,630	18
Sept 1975	535.1	1.9	5,310	20
Aug 1976	529.6	1.4	3,800	16
Mar 1977	548.6	3.9	10,900	46

Zero stage = 518 feet msl

research of published U.S. Geological Survey data and newspaper accounts. These records indicate the floods of October 1869 and December 1878 were severe, causing considerable damage throughout the watershed. Other early floods in the Westfield River basin occurred in March 1776, September 1826, February 1840, January 1841, April 1843, May 1854, April 1862, April 1869, September 1879, January 1880, April 1895, March 1896 and February 1909. The order of magnitude of these events is now known; however, they were all smaller than the August 1955 flood, which is the maximum of record.

c. Recent Floods. Reliable records of flood stages in the watershed have been tabulated since 1909. Minor floods are frequent and occur nearly every spring, usually due to melting snow or in the combination with heavy rains. Six major floods that have occurred in the basin since 1927 are briefly described in the following paragraphs. Flood information for these events at selected locations in the watershed are given on page i at the front of the Manual.

(1) November 1927. In late October 1927, a tropical storm formed over the Caribbean, then started northward on 1 November, and arrived at the lower end of Chesapeake Bay on 3 November. The storm followed a path over western Massachusetts and Vermont, causing the greatest flooding on the Vermont tributaries of the Connecticut River, and serious flooding in New Hampshire and western tributaries of Massachusetts. In the Westfield area, flooding resulted from heavy rains falling on an already saturated ground. Rainfall totals from 2 to 4 November 1927 at Westfield, Chester and Peru were 4.7, 7.5 and 6.0 inches, respectively. The maximum 24-hour rainfall at these areas were 3.9, 7.0 and 5.6 inches, respectively. Peak flows during this event at Middle Branch near Goss Heights, Westfield River at Knightville and the Westfield River at Westfield were 110, 98 and 86 cfs per square mile (csm) of contributing drainage area, respectively. Total volume of runoff at the Westfield gage from 3 to 10 November was 4.3 inches. The maximum gage height at Westfield for this period was 25.4 feet, equivalent to 41,000 cfs.

(2) March 1936. After the first week of March 1936, unseasonably warm temperatures in New England continued for the remainder of the month. Snow cover in most of the Connecticut River basin was above average as little thawing had occurred in

January and February. During the period 9-22 March, three storm centers passed over New England, with heavy rainfall on 11-12 and 17-18 March. The total storm rainfall at Chester, Peru and Westfield was 8.5, 7.8 and 6.5 inches, respectively. Water equivalent of the snowmelt during this period was estimated at about 5 inches. During this storm, peak flow readings at the gages on the Middle Branch near Goss Heights, Westfield River at Knightville, and Westfield River at Westfield were 160, 158 and 97 csm, respectively. Total runoff at the Westfield gage between 9-22 March was about 9.5 inches, and a flow of 46,700 cfs (27.2-foot gage height) was observed. The Connecticut River at Hartford crested at 37.6 feet, causing the greatest flood in over 300 years of record. On the Connecticut River, from the vicinity of Fifteen Mile Falls to its mouth, all previously known flood discharges were exceeded except in that part just downstream of White River Junction, Vermont where the peak was less than that of the November 1927 event.

(3) September 1938. A major hurricane preceded by a week of abundant rainfall caused serious flooding in the Connecticut River basin on 21 September. Storm rainfall for the period from 17-22 September for Chester, Peru and Westfield was 10.3, 9.1 and 9.0 inches, respectively. Peak flows during this event at the Goss Heights, Knightville and Westfield gages were 375, 234 and 112 csm, respectively. Total runoff at Westfield for the period 20-25 September was about 5 inches. This was the second largest flood on the lower Connecticut River and the greatest of record on many of its tributaries in the central and lower portions of the basin. The flood crested at 35.4 feet in Hartford, which was the second highest of record. The Westfield River at Westfield reached a stage of 29.4 feet, equivalent to 53,500 cfs. Tributary components for this event on the Westfield River are shown on plate H-41 and reservoir regulation in a recurrence of this flood is shown on plate H-42.

(4) December 1948. This event resulted from precipitation over the watershed from 29 December to 1 January, with rainfall in the area amounting to approximately 9 to 10 inches in the upper basin and 3.7 inches in Westfield. Knightville Dam which had been completed in 1941 filled to slightly above spillway crest. Peak discharges at Westfield and at Goss Heights were 65 and 180 csm, respectively. Total runoff for this period was about 3 inches at the Westfield River. Regulation for this flood at Knightville is shown on plate H-43.

(5) August 1955. This flood of record in the Westfield River watershed resulted from 20 inches of rain from hurricane "Diane" falling on ground already saturated from 6 to 9 inches of rain the previous week. Rainfall totals at Chester, Peru and Westfield for the period 11-20 August 1955 were 17.8, 13.0 and 25.9 inches, respectively. Peak discharges for this period at Goss Heights and Westfield gages were 310 and 140 csm, respectively. Total runoff at Westfield from 13 to 25 August was 6.2 inches. The stage on the Westfield River at Westfield reached 34.2 feet, equivalent to 70,300 cfs. Peak inflow into Knightville was 16,000 cfs and peak reservoir stage was 100 feet. Tributary components for this flood on the Westfield are shown on plate H-42 and reservoir regulation on plate H-42.

(6) October 1955. This flood resulted from a slow moving storm which deposited up to 13 inches of rain in the watershed between 14-17 October. Rainfall totals in Chester, Peru and Westfield were 11.1, 7.6 and 13.4 inches, respectively. Total runoff at Westfield for the period 15-19 October was 5.3 inches. Knightville Dam was filled to a 127.8 foot stage or 96 percent capacity and peak inflow was 20,000 cfs.

12. ANALYSIS OF FLOODS

a. Westfield River. Floodflows and precipitation records as well as regulation experience at Knightville and Littleville were reviewed to determine runoff characteristics of the Westfield River watershed. Considerations were: time of year when floods may occur, effect of topography, relative timing and flood peak contributions at downstream damage centers on the Westfield and Connecticut Rivers. The analysis resulted in the following conclusions:

(1) Floods develop very rapidly in the watershed. Cresting occurs about 4 hours after an intense rainfall on the principal tributaries of the Westfield River. At Westfield, the time of concentration is about 8 hours following heavy precipitation.

(2) Moderately high sprintime discharges occur frequently as a result of melting snow but runoff from this source alone has been insufficient to cause a major flood. However, rainfall in conjunction with snowmelt runoff is a possibility every year and could result in floodflows in the Westfield River watershed and Connecticut River basin.

(3) Peak flow from the spring runoff is generally of a lesser magnitude than one resulting from an intense summer-type storm.

(4) The watershed responds quickly to periods of heavy rainfall, and since this type of rainfall occurs any time of the year, there is no flood-free season in the Westfield River watershed.

Principal flood producing tributaries to the Westfield River at Westfield include the Middle and West Branches, the Westfield Little River, and Powdermill Brook. Below Westfield, Great Brook contributes greatly to flows on the Westfield.

Large reservoirs and lakes, such as Cobble Mountain Reservoir and Congamond Lake, can be effective in the control of minor and moderate flooding in their respective tributaries. However, during large floods the modifying effects of these can be overtaxed, and the resulting high rate of spillway discharge could contribute to the flood crest on the main river.

b. Connecticut River. Flooding along the Connecticut River is caused by excessive rainfall, melting snow or a combination of both. Analyses of record floods reveal that Connecticut River floods have generally originated in one of the following manners: (1) as a general basinwide flood usually with snowmelt, (2) in the northern portion upstream of White River Junction, (3) in the central portion between White River Junction and Montague City, and (4) in the southern sector downstream of Montague City. The November 1927 event occurred in the central and upper portions of the basin, the March 1936 flood was basinwide causing considerable rainfall and snowmelt throughout the basin, the September 1938 event originated in the lower and central portions of the basin, and the flood of August 1955 was a lower basin event.

c. Ice Jam Flooding. During the spring runoff period, consideration should be given to possible ice jam flooding along the Westfield. Although normally not serious on this river, ice jam flooding has occurred on the Westfield above the confluence of the Middle Branch above the confluence of the West Branch at Huntington and at Russell, Massachusetts on the Westfield River at Route 20.

13. DESIGN FLOODS

a. Spillway Design Flood

(1) Knightville Design Criteria. As presented in the "Analysis of Design," 1939, the forecast worst storm in the Knightville watershed, based on R&H 39, was developed by the National Weather Service in conjunction with OCE. A design storm unit hydrograph was derived from an analysis of several unit hydrographs for experienced storms in the Westfield River watershed. This unit hydrograph was then applied to the maximum predicted storm resulting in the computed spillway flood. The ordinates of discharge of the computed unit hydrograph were increased by 1.70 without changing the storm duration: thus, peak discharge and volume were increased 70 percent while the storm period remained unchanged.

Precipitation from the forecast worst storm was 16.4 inches in 24 hours (infiltration - 0.8 inch and rainfall excess - 15.6 inches). The reservoir inflow and outflow peaks were 113,000 (700 csm) and 91,000 cfs (560 csm), respectively, for the spillway design flood.

Spillway design requirements included: pool at spillway crest at start of spillway design flood, gates closed during entire flood period and maximum wave heights occurring at time of maximum spillway discharge.

(2) Knightville 1975 Criteria. Pursuant to the authority contained in Public Law 91-611, 91st Congress, Section 216, dated 31 December 1970, a review was made of the spillway design and real estate acquisitions at selected older dams and lakes in the New England Division to determine whether they conform adequately with current policies and criteria with respect to safety and functional reliability. The Knightville Dam report, completed in September 1975, included a determination of the adequacy of spillway discharge capacity and freeboard allowances. Peak inflow and outflow for the SDF are 145,000 cfs (900 csm) and 137,000 cfs (850 csm) from 17.5 inches of runoff. A summary of original and 1975 hydrologic design criteria is given in table H-11.

The results of this study demonstrated that the present spillway at Knightville Dam does not meet capacity requirements of current design criteria. The spillway design flood developed in this study would not overtop the dam but would encroach 2.3 feet on the original 5 feet of freeboard, resulting in a remaining freeboard of only 2.7 feet. Althrough the discharge capacity of the spillway does not fully meet present hydrologic design criteria, immediate correction of this problem is not considered necessary. However, if major modification of Knightville Dam is planned for structural or other

reason, increasing the height of the dam to conform to current freeboard design criteria should be included. The revised spillway design flood is illustrated on plate H-44.

(3) Littleville Design Criteria. Design Memorandum No. 1, Hydrology and Hydraulic Analysis, April 1961, presents the design criteria for Littleville Lake. The spillway design flood represents the flood developed by using the probable maximum precipitation (PMP), the highest runoff factor and most severe runoff producing combinations for the drainage area. The spillway design flood was determined by applying an adopted unit hydrograph (the computed unit hydrograph developed from the September 1938 flood and increased by 16 percent) to the rainfall excess. Reservoir peak inflow and outflow were 98,000 and 92,000 cfs, respectively.

Spillway design requirements include: reservoir filled to spillway crest at start of spillway design flood, gates operable throughout the flood period, and maximum wind and wave action occurring at time of a maximum surcharge. Regulation during the spillway design flood is illustrated on plate H-45. A summary of design criteria for Littleville is presented in table H-11. Since this project is relatively new and its design criteria is the same as that currently used, no further studies are necessary.

b. Standard Project Flood. A standard project flood for Westfield, Massachusetts was developed from standard project storm rainfall, as described in Civil Engineering Bulletin 52-8, and unit hydrographs derived from analyzing recorded floods in the watershed. This flood was used in determining hydraulic design criteria for the proposed Westfield Local Protection Project.

The 24-hour standard project storm volume averaged 8.80 inches over the basin and losses totaled 1.40 inches, yielding a rainfall excess volume of 7.40 inches. Regulation of the reservoirs and natural and modified hydrographs at Westfield for this flood are shown on plate H-46.

14. FLOOD DAMAGES

a. Flood of August 1955. The record flood caused damages of $8 million (in 1955 dollars) in the Westfield River

TABLE H-11

SPILLWAY DESIGN CRITERIA
KNIGHTVILLE DAM AND LITTLEVILLE LAKE

Item	Knightville Dam		Littleville Lake
	Design Criteria	1975 Criteria*	Design Criteria
Spillway Design Storm			
Basis of Design	R&H #39	HR #33	HR #33
Volume of Rainfall (inches)	16.4	18.8	25.1
Total Losses (inches)	0.8	1.2	2.7
Storm Duration (hours)	24.0	24.0	30.0
Unit Hydrograph			
Unit Rainfall Duration (hrs)	6.0	3.0	3.0
Peak Flow (cfs)	11,700	11,000	8,000
Spillway Design Flood			
Peak Inflow to Res. (cfs)	113,200	145,000	98,000
Volume of Runoff (ac-ft)	134,000	152,000	62,500
Peak Outflow (cfs)	91,000	137,000	92,000
SDF Reservoir Regulation Plan			
Initial Pool Elevation (ft, msl)	610	580	576
Outlet Facility During Flood	Closed	Operable	Operable
Maximum Surcharge Elevation (ft, msl)	625	627.3	591
Freeboard Characteristics			
Design Wind Velocity (mph)	80	80	78
Effective Fetch (miles)	--	0.63	0.73
Average Depth (feet)	--	90	--
Wave Runup (feet)	3.5	3.25	3.05
Wind Tide (feet)	--	Negligible	0.05
Adopted Freeboard (feet)	5.0	5.0	5.0
Top Elevation of Dam (ft, msl)	630	630	596.0

* Pool initially one-half full

watershed, with most damage occurring in Westfield.

b. Damages Prevented. The Littleville and Knightville Reservoirs are regulated to provide flood protection for downstream communities, especially Westfield. They are also regulated with a comprehensive system of reservoirs to reduce flood stages along the main stem of the Connecticut River. Since construction, the Littleville and Knightville projects have prevented damages estimated at $950,000 and $19,200,000, respectively.

15. DROUGHTS

a. General. The Westfield River watershed lies within the general zone classified as humid, where the average annual precipitation is distributed reasonably well throughout the year. In National Weather Service terminology, a drought is considered to be a period of 14 or more days in which less than 0.1 inch of precipitation falls in a 48-hour period. To the agriculturalist, a drought is a lack of soil moisture during the growing season. Hydrologically, a drought is defined as a prolonged period of precipitation deficiency which seriously affects riverflow as well as surface and ground water supplies. Periods of deficient precipitation and runoff have occurred in the watershed.

b. History. The drought history in the watershed extends back more than 100 years. Several periods of below average precipitation have occurred prior to 1960, with the most notable in 1880 to 1883, 1894, 1930 to 1932, and 1941. The most severe period prior to 1960 was from 1930 to 1932 and was used by many communities as design criteria for water supply purposes.

c. Drought of 1961 to 1966. This drought was the longest and most severe in the history of the Connecticut River basin. During this period, the cumulative precipitation deficiency at Westfield was 60.2 inches, or 133 percent of the average annual precipitation. The cumulative runoff deficiency for water years 1961 to 1966 at the Westfield River at Westfield was 47.3 inches or about 184 percent of the average runoff. Rarely is a deficiency of ground water carried over from one growing season to the next in New England, since it is replenished during each spring runoff. However, this

condition occurred in the winter of 1964-1965, resulting in a runoff on the Westfield River at Westfield of 11.09 inches or about 43 percent of the average yearly runoff (refer to plate H-25).

CHAPTER IV

COMMUNICATIONS

16. GENERAL

All communications between the Project Managers and RCC are made via the NED radio network during normal work hours or when NED headquarters are otherwise manned. Whenever the radio network is inoperative, communications are made by telephone. During nonwork hours, reports and regulation instructions are issued via telephone to or from the homes of WCB personnel. In the event of failure of the NED radio network and telephone service, emergency communications will be attempted through the State Police or Civil Defense radio facilities. In addition, radios located in the Automatic Hydrologic Radio Reporting Network facilities in the field are tied directly to the RCC computer room, serving as a backup system for normal radio communication. Location of the sites are listed in paragraph 19.

17. PRECIPITATION REPORTING NETWORK

Reports of precipitation data from the Westfield River watershed are used primarily for the purpose of alerting RCC personnel and for providing a basis for appraising the severity of the storm. Collection and reporting of precipitation data from Knightville Dam and Littleville Lake is the responsibility of the Project Managers who also receive calls from observers in the watershed. Identification and location of these observers are listed in the RCC telephone directory which is updated annually.

The Reservoir Control Center periodically reviews network arrangements to insure that an adequate reporting network is maintained. The Northeast River Forecast Center in Bloomfield, Connecticut receives precipitation reports from observers in and near the Westfield River watershed, which are made available to RCC upon request. In addition, cooperative reporting procedures from most Corps dams have been established with the River Forecast Center and have been detailed in separate memos to each

Project Manager. Locations of the National Weather Service precipitation stations are shown on plate H-3.

18. RIVER REPORTING NETWORK

a. General. A network of river stage observation stations, which is part of an overall river reporting system for the Connecticut River basin has been established. This network assists in the execution of the reservoir regulation plan by permitting personnel in RCC and at the dams to obtain river stages at selected key index stations located on tributaries or on the Connecticut River.

b. River Reporting System. The river reporting system in the Westfield River watershed consists of a USGS gage on the West Branch Westfield River at Huntington, and a USGS gage on the Westfield River in Westfield. Other gages on the Westfield River at Knightville and the Middle Branch Westfield River at Goss Heights are downstream of Knightville Dam and Littleville Lake and serve as indicators of the discharge from the dams. The Montague City, Springfield, and Hartford telemarks on the Connecticut River are also used in the river reporting system. A brief discussion on each follows:

(1) Westfield River

(a) Westfield River near Westfield. The USGS gaging station near Westfield (see plate H-31) measures runoff from 497 of the total 517 square mile watershed. The gage is located on the left bank of the Westfield River, 0.7 mile downstream of Great Brook and 3 miles east of the city of Westfield. The gage has been in operation almost continuously since 1914 and is telemark equipped.

(b) West Branch Westfield River at Huntington. The USGS gage at Huntington (see plate H-32) is located on the left bank of the West Branch, 0.4 mile downstream from Roaring Brook and 1.5 miles upstream from the mouth. This gage records the runoff from 93.7 square miles or practically the entire contribution of the West Branch to the Westfield River. The gage has been in operation since September 1935, and is telemark equipped.

(c) Middle Branch Westfield River, Goss Heights. The USGS gage at Goss Heights (see plate H-33) is located on the

right bank of the Middle Branch at the Goss Heights highway bridge, 0.35 mile upstream from the mouth and 1.7 miles north of Huntington. This gage records the runoff from the Middle Branch drainage area of 53.0 square miles, of which 52.3 are controlled by the Littleville Reservoir. This gage has been in operation since July 1910.

(d) Westfield River at Knightville. The Knightville gage (see plate H-34) is located on the left bank of the Westfield River, 0.2 mile downstream from Knightville Dam, 0.2 mile upstream from Sykes Brook, 2.4 miles upstream from the mouth of the Middle Branch and 3.5 miles north of Huntington. The gage records runoff from a drainage area of 162 square miles or the drainage area of the Knightville Reservoir and is read remotely at Knightville Dam. This gage has been in operation since August 1909.

(2) Connecticut River

(a) Connecticut River at Montague City. The USGS gage at Montague City (see plates H-26 and 27) is located on the left bank of the river 75 feet downstream from the NYNH&H Railroad bridge at Montague City and 1,000 feet downstream from the mouth of the Deerfield River. This gage records runoff from 7,865 square miles and has been in operation since 1904. This gage is telemark equipped.

(b) Connecticut River at Springfield. This gage (see plate H-28) is situated on the left bank at the York Street pumping station, approximately 4,500 feet downstream from Memorial bridge and about 3,000 feet above the confluence of the Westfield and Connecticut Rivers. It is used to measure stages associated with runoff from a drainage area of 9,587 square miles, including the Westfield River drainage area,during flood periods. Data from the gage is automatically transmitted via radio signal to the Reservoir Control Center.

(c) Connecticut River at Hartford. The National Weather Service gage on the Connecticut River in Hartford, Connecticut (see plate H-28) is located on Bulkeley bridge in Hartford. This gage is in a natural storage reach, resulting in a hysteresis curve for the stage-discharge relationship. During flood periods it is suggested that this gage be used as an indicator of stage but not

for determining discharge. The Connecticut River at this gage, which has been in operation since 1902, has a drainage area of 10,428 square miles. The station is telemark equipped. Information concerning other key locations along the Connecticut River and its tributaries are obtained from other Project Managers of flood control projects and the River Forecast Center.

19. AUTOMATIC HYDROLOGIC RADIO REPORTING NETWORK

The effective regulation of flood control projects in New England, consisting of 35 flood control dams and 4 hurricane barriers, requires a reliable and rapid method of collection and coordinating hydrologic data by the Reservoir Control Center. In January 1970, the installation of an Automatic Hydrologic Radio Reporting Network (AHRRN) was completed.

Radio gaging stations have been established at the following locations in the Connecticut River basin:

Connecticut River at Wells River, Vermont
White River at West Hartford, Vermont
Connecticut River at White River Junction, Vermont
Connecticut River at North Walpole, New Hampshire
Ashuelot River at Keene, New Hampshire

Deerfield River at West Deerfield, Massachusetts
Connecticut River at Montague City, Massachusetts
Chicopee River at Indian Orchard, Massachusetts
Westfield River at Westfield, Massachusetts

Connecticut River at Springfield, Massachusetts
Mad River Lake at Winchester, Connecticut
Farmington River at Collinsville, Connecticut
Farmington River at Rainbow, Connecticut
Connecticut River at Hartford, Connecticut

Plate H-47 shows a computer printout of a typical interrogation. Related information from the interrogation (see plate H-48) is transmitted to the Project Manager at Littleville Lake.

Details of the computer controlled radio hydrologic reporting network are covered in a report prepared by RCC in August 1976, entitled: "Flood Control, Automatic Hydrologic Radio Reporting Network."

20. LANDSAT EXPERIMENT

In June 1972, NED entered into a contract with NASA for an experiment to study the feasibility of using the Earth Resources Technology Satellite ("ERTS" or "LANDSAT") for collecting hydrologic data from Data Collection Platforms which were installed at about 25 locations throughout New England, with many situated at USGS gaging stations. A major objective of this experimental program has been to compare the cost, reliability, and operational effectiveness of the LANDSAT Data Collection System with the existing NED (AHRRN) radio network. The results and recommendations are summarized in a final report to NASA in September 1977.

21. REPORTS

a. Weekly Reports. The Project Manager makes a routine report via radio (or telephone) to RCC each Friday morning. This report insures continuous contact between operating personnel and RCC, and also serves as a check on the communications network. The report includes the preceding 24-hour precipitation, current weather conditions at index stations and other miscellaneous data. A sample of a completed NED form 477 is shown on plate H-49.

b. Alerting Reports. An alerting report is promptly made and includes pertinent data that is readily available together with a general appraisal of local conditions although data from all precipitation or flood index stations may not be available. Whenever any of the following conditions occur, the manager will immediately notify RCC:

(1) Precipitation. Occurrence of 1-inch precipitation or any other amount as indicated by RCC, during any 24-hour period at either Knightville Dam or Littleville Lake.

(2) Reservoir Stages. A reservoir stage of 25 feet and rising during the nonfreezing season or 30 feet and rising during the freezing season at Knightville Dam or a reservoir elevation of 522 feet msl and rising at Littleville Lake.

(3) River Stages. Whenever a rising Westfield River reaches the following stages at the following locations:

Westfield River at Westfield gage - 8 feet (3,720 cfs)
West Branch at Huntington - 3.8 feet (1,640 cfs)

(4) Unusual Conditions. Unusual local conditions such as difficulty with the gates, ice jams, excessive debris, bridge failures, etc. will be reported.

c. Supplemental Reports. Supplemental radio (or telephone) reports are made to RCC by the Manager either following instructions from RCC or if it appears that flood conditions might develop in the watershed as the result of melting snow, ice jams, dam failures or heavy localized rainfall. The time and frequency of these reports are dependent upon the severity of conditions and specific instructions from RCC. Plate H-50 shows a typical reporting log, indicating the data to be included in reports by the Project Manager during flood periods. Insofar as practicable, the following information is included in the flood report to RCC.

(1) Precipitation at Dam. The total amount of precipitation which has fallen up to the time of reporting and several intermediate amounts with times of observation, as indicated by RCC.

(2) Reservoir Stage. The pool stage at time of reporting and several previous readings with corresponding times to determine the rate of rise and define the inflow hydrograph. Accurate readings of stage and time are essential to facilitate computation of inflow (see plates H-51 through H-53).

(3) Gate Positions. Gate openings and discharges at time of reporting and at beginning of storm. Any gate changes since preceding report should be included with corresponding stage and discharge.

(4) Precipitation Reports from Observers. Rainfall data received from cooperative observers.

(5) River Stages. Westfield River stages with times of observations from gages at Huntington and Westfield as requested by RCC.

(6) Snow Cover. General snow cover which may affect runoff conditions throughout the basin.

(7) Miscellaneous Data. Any other information which might be pertinent such as temperature, etc.

d. Special Reports. A special report is submitted by the

Manager to RCC whenever unusual circumstances occur during a flood or as requested by RCC. The report may be written in long-hand and should describe the subjects outlined below if appropriate.

(1) Observations at Dam. The Manager makes general observations of conditions occuring at the outlet works as listed on the following page. The observations are entered in the log book at the dam. If possible, photographs are taken of any unusual conditions, noting date, time, reservoir gage heights and position of the gates. Observations which should be reported to RCC are:

(a) Extent and action of eddies and waves in the vicinity of the conduit intakes and portals.

(b) Extent and action of turbulence or eddies downstream of the spillway and outlet works.

(c) Effect on flow through the gates due to an accumulation of ice or debris at the intake.

(d) Pool elevation and position of gates where gate vibration or whirlpools develop.

(e) Any seepage, noting color of discharge, or embankment sloughing, which may appear at the downstream side of the dams or dike.

(f) Any other unusual hydraulic phenomena that may occur.

(2) Observations at Downstream Control Points. During periods of reservoir regulation, particularly while emptying the reservoir, reconnaissance of downstream conditions is made by either or both Managers, upon specific authorization of RCC, to obtain further flood data in any of the downstream damage areas or control points on the Westfield or Connecticut Rivers.

e. Snow Survey Reports. Snow courses have been established at selected locations within the upper watershed (see table H-6). Weekly surveys are made by the Managers during winter and early spring to determine the depth of snow and equivalent water content. Dates for surveys are determined each year by RCC so as to correspond with monthly bulletins of the U.S. Geological Survey and supplemental data from State agencies and

power companies. The report will contain the name of the station, snow depth and water equivalent.

f. Northeast River Forecast Center Reports. The Project Manager at Knightville Dam or Littleville Lake will make a daily telephone call at 0815 hours to the Northeast River Forecast Center (NERFC) for the purpose of transferring hydrologic and climatologic conditions at the reservoirs. The following parameters will be reported on a 7-day basis:

Dam
Date
Time of observation
Precipitation (24-hour)
Present weather
Depth of new snow
Total depth of snow
Temperature - maximum preceding 24 hours
Temperature - minimum preceding 24 hours
Temperature - current

The above data will be used to develop a Westfield River headwater statement. The statement, transmitted by NERFC to RCC twice weekly, gives the amount of rainfall in 6 hours required to produce runoff varying from .25 to 5 inches into our reservoirs.

22. SPECIAL ADVISORIES

In accordance with regulations set forth in EM 500-1-1, "Domestic Emergency Operations," and the "Guidance Memorandum, Reservoir Control Center," special advisories from RCC on flood potential and progress of all threatening storms are submitted to the Division Engineer and to the Chiefs of Engineering and Operations Divisions. Flood reports are also prepared for OCE by RCC.

23. MAINTENANCE OF LOG

All reports, instructions, records of unusual circumstances at the dam, and information pertinent to regulation of the reservoir are entered in the logs (NED Form 503). A log is maintained by the Project Managers and Reservoir Control Center.

24. GATE OPERATION RECORD

All gate operations are carefully noted on NED Form 90, a sample of which is shown on plate H-54 and submitted bimonthly to RCC. All operations are noted regardless of the duration of the change in gate position. The report includes data and time of day, reservoir stage, outflow, precipitation, gate opening, tailwater reading and remarks column. RCC personnel utilize the Form 90's in the preparation of the monthly charts of reservoir regulation, which serve as permanent records of reservoir operation when the projects become operational. Form 90's are also utilized in the preparation of yearly reservoir regulation exhibits for the RCC Annual Report, which is sent to OCE, NED personnel, other agencies, and to the public.

CHAPTER V

HYDROLOGIC FORECASTS

25. NATIONAL WEATHER SERVICE

a. Weather Forecasts. The National Weather Service in Boston, Massachusetts is responsible for issuing daily weather forecasts for public dissemination through the news media. These reports are received at RCC approximately four times each day on the Weather Service teletype loop.

b. Precipitation Forecasts. In addition to the normal weather forecasts, quantitative precipitation forecasts are received daily by RCC. Supplemental weather information and forecasts prior to or during floods are made available upon request.

c. River Forecasts. The Northeast River Forecast Center at Bloomfield, Connecticut is responsible for preparing and disseminating flood forecasts for the Connecticut River and some of the principal tributaries. Flood forecasts in the Connecticut River basin are listed for the following locations:

Connecticut River at North Stratford
Connecticut River at Dalton
Connecticut River at Wells River
Connecticut River at White River Junction
Connecticut River at North Walpole

Connecticut River at Montague City
Connecticut River at Thompsonville
Connecticut River at Hartford
Connecticut River at Bodkin Rock
Passumpsic River at Passumpsic

Ammonoosuc River at Bath
White River at West Hartford
Chicopee River at Indian Orchard
Farmington River at Rainbow

Stages on the Westfield River at Westfield are also monitored for the purpose of preparing flood forecasts; however, these

forecasts are not included with the previous listed stations when a flood forecast statement is issued by NERFC.

26. CORPS OF ENGINEERS

a. Westfield River Forecasts. During flood periods in the Westfield River watershed, the Knightville and Littleville Reservoirs are operated to protect the downstream community of Westfield. The Westfield River enters a large flood plain in the city, and extensive development in this area has limited the nondamaging channel capacity to approximately a 14-foot stage at the Westfield gage, or about 13,000 cfs (26 csm).

Operating experience at both projects has shown that regulating for specific river conditions at Westfield, Knightville and Littleville Reservoirs automatically provide protection to other communities downstream where channel capacity is greater. The two reservoirs control about 65 percent of the Westfield River drainage area at Huntington, about 45 percent at Westfield and 40 percent at the mouth.

During a flood period, the Knightville Project Manager continually monitors river stages at Huntington and Westfield, which can be accomplished quite easily as both gages can be interrogated via telephone. High flow travel times from both reservoirs to Westfield is 4 to 5 hours and from Westfield to the mouth of the river, another 3 to 5 hours. Considering these hydrologic characteristics of the Westfield watershed and the fact that RCC continually receives weather, quantitative precipitation and flood forecasts from the National Weather Service, data from the automatic hydrologic radio reporting system and the other 25 manned dams, it has not been considered necessary to develop a specific flood forecasting procedure for the Westfield River.

b. Future Flood Forecasts. The Master Manual for the Connecticut River basin has been initiated and will include procedures for Connecticut River flood forecasting and releasing of stored waters from the entire reservoir system during recession of a flood.

In December 1971, the Reservoir Control Center requested the Hydrologic Engineering Center to develop a flood forecasting technique for the Merrimack River basin based on "real time"

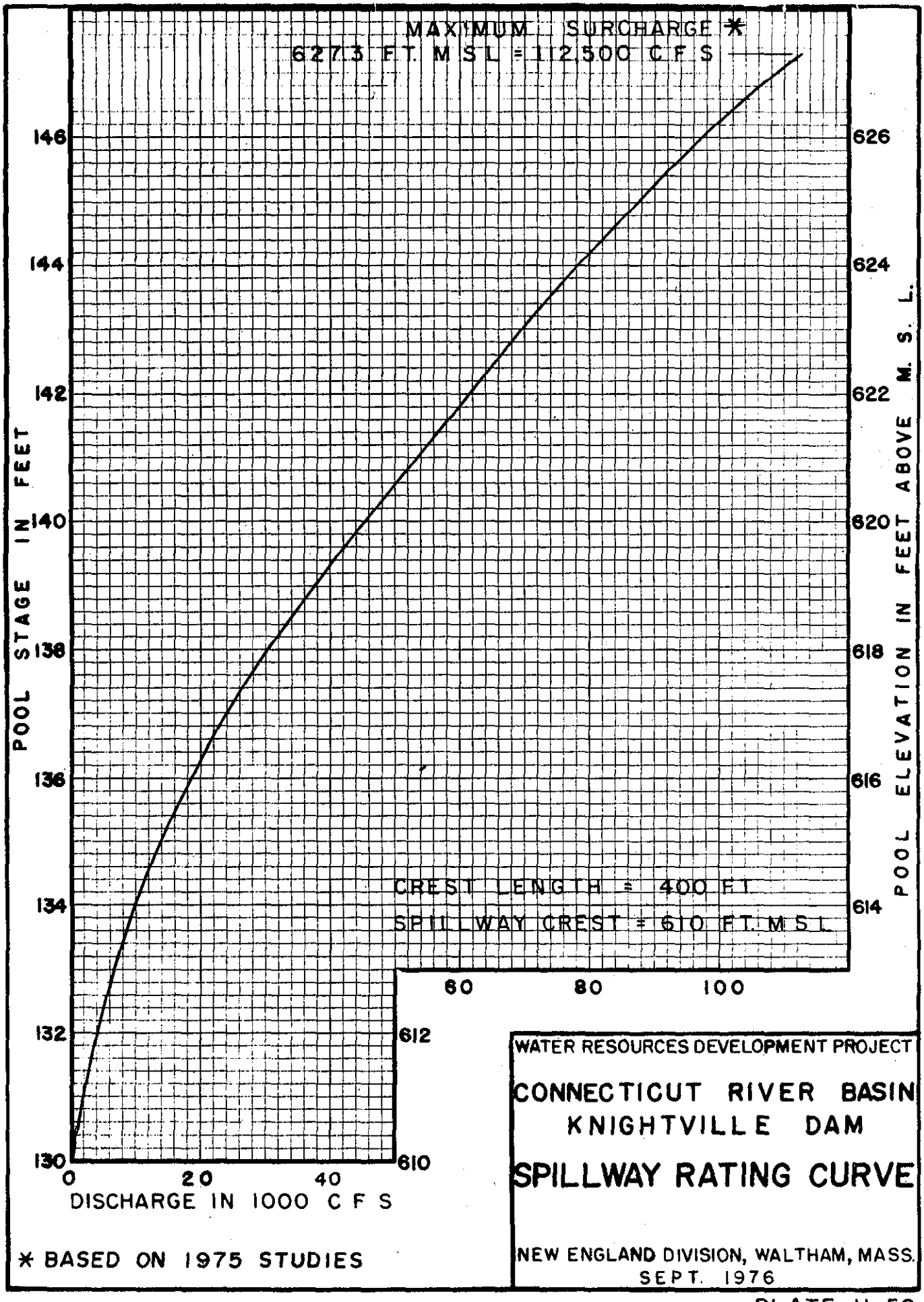

MAXIMUM SURCHARGE *
627.3 FT. M S L = 112,500 C F S
146
144
142
140
138
136
134
132
130
626
624
622
620
618
616
614
612
610
POOL STAGE IN FEET
POOL ELEVATION IN FEET ABOVE M. S. L.
CREST LENGTH = 400 FT.
SPILLWAY CREST = 610 FT. M S L.
60
80
100
0
20
40
DISCHARGE IN 1000 C F S
* BASED ON 1975 STUDIES
WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
KNIGHTVILLE DAM
SPILLWAY RATING CURVE
NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-59

CHAPTER VI

RESERVOIR REGULATION

27. PLAN - GENERAL OBJECTIVES

The general objective of the regulation procedures for the Westfield River watershed is to provide a comprehensive tool for guiding those responsible for operating Knightville Dam and Littleville Lake in accomplishing the missions for which these projects were authorized. This plan will allow for the most efficient protection of immediate downstream communities on the Westfield River and communities further downstream on the Connecticut River. Procedures for maintaining and operating the water supply pool and facilities are also included.

28. NONFREEZING SEASON

Knightville Dam is authorized as a dry bed reservoir and will have a normal gate setting during the nonfreezing season of 3'-3'-3'.

A water supply pool will be maintained year round up to 518 feet msl at Littleville Lake. The normal gate setting during the nonfreezing season is 3'-3'.

29. FREEZING SEASON

A winter pool will be maintained at Knightville Dam at a stage between 15 and 20 feet to prevent freezing of the flood control gates. The pool will be developed gradually with some water being released continually. Once the pool is established the Project Manager will make small adjustments (maximum gate opening at each gate not to exceed 3 feet) in gate openings to maintain the pool at a relatively constant level. RCC will instruct the Project Manager when the winter pool is to be established in the fall and lowered in the spring.

If a winter pool at Knightville continues to rise above 30 feet with 3-foot gate openings, the Reservoir Control Center will be contacted for instructions.

During cold weather at Littleville Lake, the flood control

gates will be operated daily to prevent freezing. The normal gate setting during the freezing season will be 3'-3'.

Operating experience at Littleville has indicated that gate freezing is not normally a problem. However, if gate freezing creates difficulty at Littleville, the two flood control gates will be throttled sufficiently to keep them submerged.

30. FLOOD CONTROL

a. Objective. Flood control objectives of both Knightville Dam and Littleville Lake are directed to provide flood protection to Westfield and other downstream communities on the Westfield River, and in conjunction with other flood control reservoirs in the Connecticut River basin, to alleviate flooding at downstream communities on the main stem of the Connecticut River.

b. Regulating Constraints

(1) Minimum Releases. A minimum release of about 10 to 20 cfs should be maintained from each project during periods of flood control regulation in order to sustain downstream fish life.

(2) Flowage Easement in Reservoirs. Land is owned in fee to spillway crest elevation at Knightville (610 feet msl - 130 foot stage), and 5 feet above spillway crest at Littleville (581 feet msl). It is possible that adjacent lands which are above fee taking could become inundated during a rare flood; therefore, observations will be made periodically by the Project Manager to determine if any development has occurred which could be affected. These inspections will be conducted by the Project Managers or their assistants.

(3) Recreation Areas. Since inundation of the Indian Hollow camping area at Knightville Dam begins at a stage of 80 feet, consideration should be given to minimizing the inundation of these facilities.

(4) Downstream Developments. When ice jamming is a possibility on the Westfield River, observations should be made to determine if releases from the projects are affected by downstream ice jams, hence creating problems to developments along the river.

31. FLOOD PERIOD

a. General. Regulation of flows from Knightville Dam and Littleville Lake are initiated for heavy rainfall over the Westfield River watershed and also for specific river stages at key Westfield and Connecticut River index stations. Regulation may be considered in three phases during the course of a flood: Phase I - the appraisal of storm and river conditions during development of the flood leading to the initial regulation, Phase II - regulation of projects while the Westfield River and/or Connecticut River floodflows crest and move downstream, and Phase III - emptying the reservoir following downstream recession of the flood. The standard operating procedures (SOP) for regulating the reservoirs are shown on plate H-55.

b. Phase I - Appraisal, Initial Regulation. During this phase it is important to collect rainfall and discharge data in order to appraise the development and magnitude of a flood in the basin. Collection of data is facilitated at Littleville by a teletype machine which receives reports from the automatic hydrologic reporting network. Information from regular interrogations in Waltham from stations in western Massachusetts and Connecticut is automatically transmitted from RCC to Littleville. In addition, these stations can be manually interrogated by the Littleville Manager (a sample printout from the teletype is shown on plate H-48).

Also during Phase I gate operations at Knightville Dam and Littleville Lake will be initiated to restrict the reservoir discharge in accordance with the SOP on plate H-55. The portion of the total to be released from each reservoir will be directed by RCC.

Consideration will be given to partial closure of the gates at both projects (Knightville 1'-1'-1' and Littleville 1'-1') for any of the following conditions:

(1) Whenever a rainfall of 2.0 inches on snow-covered, wet or frozen ground or 3.0 inches on dry ground occurs within a 24-hour period at either dam.

(2) Whenever the stage at the USGS gage at the West Branch River in Huntington reaches 6.0 feet (4,100 cfs) and rising. A stage discharge table is shown on plate H-32.

(3) Whenever the stage at the USGS gage at Westfield

reaches 12.0 feet (9,570 cfs) and rising. A stage-discharge table is shown on plate H-31.

(4) When the Connecticut River is rising and approaches the following stages:

26 feet at Montague City	(68,800 cfs)
16 feet at Springfield	(104,000 cfs)
16 feet at Hartford	(66,000 cfs)

c. Phase II - Continuation of Regulation. An important regulation activity during this period is the collection of hydrologic data such as: (1) precipitation amounts throughout the watershed as well as surrounding areas, (2) snow cover and water content in case of spring floods, (3) stage and discharge values at downstream control points, and (4) other pertinent data which would assist in the regulation. During this phase, the reservoir discharge is regulated to reduce downstream flooding on the Westfield and Connecticut Rivers.

As a flood develops, considerable judgment and experience are necessary to vary the regulation in accordance with the amount of residual reservoir storage at Knightville and Littleville, river stages at Westfield, water content of the snow remaining in the watershed and weather forecasts. In general, continuation of regulation will be governed principally by the stage at the USGS gage at Westfield and the reservoir pool stages.

Secondary river rises from additional rainfall or snowmelt will be considered applicable to Phase II. With rising stages at the Westfield River at Westfield, consideration will be given to travel times from the dams to Westfield in order to anticipate river stages. Approximate peak travel times to Westfield from Knightville Dam and Littleville Lake are about 4 to 5 hours.

The preceding conditions will usually govern the continuation of regulation in Phase II, but in some cases flood conditions on the Connecticut River will be the controlling factor. Generally, regulation in Phase II will continue until the flood peak has passed Hartford and flow has receded to safe channel capacity along the Westfield River and at Springfield on the Connecticut River. Approximate travel times for the watershed are listed on page i and plate H-55.

Consideration will be given to complete closure of the gates at both projects (Knightville Dam 0'-0'-0.1' and Littleville 0'-0.1')

for any of the following conditions:

(1) Whenever a rainfall of 3.0 inches on snow-covered, wet or frozen ground, or 4.0 inches on dry ground occurs within a 24-hour period.

(2) Whenever the stage at the USGS gage at Westfield reaches 13.0 feet and rising, or whenever the stage at the USGS gage at Huntington reaches 6.6 feet (5,000 cfs) and rising.

(3) Whenever the Connecticut River is rising and approaches the following stages:

28 feet at Montague City	(79,000 cfs)
18 feet at Springfield	(126,000 cfs)
18 feet at Hartford	(80,000 cfs)

d. Phase III - Emptying the Reservoirs. Following recession of the flood peak at downstream index stations on the Westfield and Connecticut Rivers, the reservoirs will be emptied as rapidly as possible. The contribution of each reservoir to the total discharge at these stations will be as directed by RCC. Releases will be made in a manner which will not cause the stages downstream to exceed the maximum stages given below.

Gage Site	Maximum Stage (feet)	Discharge (cfs)
Middle Branch River at Goss Heights	6	1,700
Westfield River at Knightville	6.6	4,500
Westfield River at Westfield	14	13,000
Connecticut River at Springfield	20	151,000
Connecticut River at Hartford	22	113,500

Rating tables for these and other gaging stations are shown on plates H-26 through H-34.

Other Phase III considerations are listed below:

(1) The rate of increase in discharge from Knightville Dam should not exceed 500 cfs per hour up to 3,500 cfs, and 250 cfs per hour up to 4,500 cfs, with the maximum rate of drawdown not to exceed about 15 feet in 24 hours.

(2) The rate of increase in discharge from Littleville Lake should not exceed 300 cfs per hour up to 1,200 cfs, and 100 cfs per hour up to 1,700 cfs, with the maximum rate of drawdown not to exceed about 5 feet in 24 hours.

(3) Discharge of the water stored at Knightville Dam and Littleville Lake will be coordinated with releases from other projects in the system in a manner that will allow the Connecticut River flood crests to continue receding. This subject will be described in detail in the "Master Regulation Manual for the Connecticut River Basin."

(4) During the growing season, agricultural lands adjacent to the Connecticut River begin to inundate when river levels rise to about a 16-foot stage at Hartford. This fact will be given consideration when regulating for floods during the growing season. Under such circumstances, a reconnaissance may be requested by RCC and appropriate action taken. However, it is noted the primary purpose of the projects is the protection of major downstream communities such as Westfield, Springfield, West Springfield, East Hartford and Hartford, and that it is important to avoid uncontrolled spillway discharge from either project.

(5) The maximum nondamaging channel capacity immediately downstream of Knightville is about 4,500 cfs. The maximum nondamaging channel capacity immediately downstream of Littleville Lake is about 1,700 cfs. These discharges should be considered by RCC whenever peak inflows have exceeded these values, and climatologic and hydrologic conditions permit. Outlet rating curves for Knightville Dam and Littleville Lake are shown on plates H-56 through H-58.

(6) Secondary river rises during Phase III, due to either additional rainfall or snowmelt, may result in regulation procedures reverting to Phase II.

(7) With the reservoirs filled to spillway crest and an inflow of 3 cubic feet per second per square mile (csm), it would require about 6 days to empty Knightville and about 8 days to empty the Littleville flood control pool. If it becomes necessary in an emergency to lower Littleville's water supply pool, discharges should be made by opening the 12- and 24-inch valves in the low flow diversion structure and discharging into the Middle Branch. With pool levels above 510 feet, about 180 cfs can be released

through these two outlets. Assuming an inflow of 1 csm per day, one-half of the water supply pool would remain after 20 days and 1 inch of storage after 29 days.

e. Regulation for Snowmelt. Moderately high springtime discharges can occur as a result of melting snow, but runoff from this source alone has not caused major flooding. Snow cover in the lower elevations of Massachusetts and Connecticut usually diminishes before melting takes place in the northern areas of Vermont and New Hampshire. However, the potential snowmelt flood threat period on the Connecticut River and its tributaries is prolonged and generally occurs in March and April due to high riverflows and saturated ground conditions.

Active snowmelt begins when density of the snowpack rises above 30 percent, i.e., a 10-inch depth of snow having 3 inches of water equivalent. RCC has not developed precise correlations regarding high temperatures - snow density-peak runoff relationships for each triburary. However, operating experience has indicated that after the snowpack becomes "ripe", several days of maximum temperatures in the fifties and sixties would result in flows of up to 20 csm in the main stem of the Westfield River and discharges up to 30 csm from the smaller, steeper tributaries in the watershed. Runoff from snowmelt alone is diurnal, orderly and gradual, and regulation by RCC personnel will not necessarily follow the release guides established for runoff associated with rainfall. Regulation during periods of snowmelt alone generally will be based on maintaining releases consistent with full downstream channel capacities.

f. Spillway Discharges. Ordinarily, during a major flood, the gates will not be opened to avoid spillway discharge. Surcharge storage above the spillway crest will be utilized if the downstream channel capacity continues to be exceeded by runoff from uncontrolled areas.

If the stored floodwaters in either reservoir continues to rise above the spillway crest with the possibility of the pool exceeding the maximum design surcharge, the following schedule will be used as a guide for gate releases during spillway discharges. This schedule will result in the gates being fully open when the pool has reached about two-thirds design surcharge.

Knightville Dam		Littleville Lake	
Pool Stage (feet)	Gate Openings	Pool Stage (ft, msl)	Gate Openings
130	0'-0'-0.1'	576	0'-0.1'
133	2'-2'-2'	579	2'-2'
136	4'-4'-4'	582	4'-4'
139	6'-6'-6'	585	6'-6'
142	12'-12'-12' (fully open)	588	8'-8' (fully open)

It should be emphasized that this would result from an extremely rare event, occurring after more than 20 inches of rainfall in 24 hours, with the reservoir full or nearly full at the beginning of the storm event. Spillway rating curves are shown on plates H-59 and H-60.

g. Alerting of Flood Affected Populace. Whenever it is anticipated that either reservoir will rise above spillway crest elevation during an extreme flood, the Project Manager will notify the Massachusetts State Police at the Russell Barracks, and the Chiefs of Police at Huntington, Chester, Russell, Westfield and West Springfield. The Police Chiefs at Huntington and Chester should be warned that portions of their communities might be inundated from water backing up from Knightville and Littleville, respectively. Telephone numbers for these and other local officials are listed in the RCC telephone directory which is updated annually.

h. Effect of Regulation on Roads Within the Reservoirs. There are several roads that pass into or through the reservoir areas at Knightville Dam that are subject to inundation during the storage of floodwaters. Inasmuch as public safety is involved in the use of these roads, the Project Manager is responsible for barricading the roads when necessary. Locations of these barricades are shown on plate H-4. These are all closed when a rising pool reaches a 40-foot stage. Gates 3, 4, 5 and 6 are closed all summer and open only in the winter for snowmobiles.

There are no roads requiring barricading in the reservoir area at Littleville Lake.

32. EXTRAORDINARY FLOOD CONDITIONS

It is conceivable that extraordinary circumstances or unpredictable flood conditions may arise such as a possibility of drowning, dam or bridge failures, highway or railroad washouts, ice jams or debris deposits. Since the purpose of the reservoirs is to save lives and prevent or reduce damage, regulation during such unusual conditions may not follow previously described rules but will be governed by the urgency of the circumstances. During such conditions the Project Manager has full authority to act immediately in the public interest. RCC will be notified as soon as possible of any unusual incident so that additional action may be taken to provide maximum protection.

33. REGULATION WITH FAILURE OF COMMUNICATION

Should both the Knightville and Littleville Project Managers be unable to contact RCC when a flood is developing, the Littleville Manager has full authority to act promptly in accordance with instructions contained in the SOP and will direct the regulation of both reservoirs until communications can be established. Should the Project Manager at Littleville be unavailable for duty, the Knightville Manager will direct the regulation of both projects according to the SOP (refer to plate H-45 and paragraph 30). It should be emphasized that whenever communications fail, or due to lack of adequate reports, and it is difficult to fully appraise the runoff from an intense storm, then it is preferable for either Manager to immediately restrict or completely stop reservoir discharges than to delay regulation and actually contribute to downstream flood conditions.

In cases of extreme emergency, the Manager shall attempt to communicate with RCC through the Massachusetts State Police and the office of Civil Defense Mobilization radio networks. In addition, all hydrologic radio reporting stations have radios that transmit directly to RCC. Paragraph 19 lists the location of these stations.

The Littleville Project Manager will regulate discharges from both reservoirs during Phase I. In case of doubt as to whether a partial or complete closure should be made, the gates will be closed completely whenever the severity of the storm and/or lack of information concerning downstream conditions warrant such action.

In the event the Knightville Project Manager is unable to contact either RCC or the Littleville Project Manager by telephone, either he or his assistant will drive to Littleville Lake to report on flood conditions. However, the project should remain staffed. Should conditions be such that immediate reduction of Knightville Dam outflow is essential, the Knightville Project Manager has full authority to make necessary gate adjustments prior to reporting to Littleville. Releases for emptying the reservoirs will not be made until contact has been established with RCC. Possession of instructions contained in this manual does not relieve the Project Manager of his responsibility for continued efforts to communicate with RCC.

34. EMERGENCY OPERATING PROCEDURES (EOP)

When unable to contact RCC and flood conditions develop, the Managers or assistants have full authority to regulate the gate openings in accordance with instructions as follows:

EMERGENCY OPERATING PROCEDURES

a. Partial Gate Closure for any of the Following Conditions:

Gate Setting: Knightville - 1'-1'-1'
Littleville - 1'-1'

Rainfall during 24-hour period:

Snow covered, wet or frozen ground - 1.5"
Dry ground - 2.0"

River Stages*: West Branch River at Huntington - 4'
Westfield River at Westfield - 9'
Connecticut River at Hartford - 18'

b. Complete Gate Closure for any of the Following Conditions:

Gate Setting: Knightville - 0'-0'-0.1'
Littleville - 0'-0.1'

Rainfall during any 24-hour period:

Snow covered, wet or frozen ground - 2"
Dry ground - 3"

River Stages*:

West Branch River at Huntington	- 5' and rising
Westfield River at Westfield	- 10' and rising
Connecticut River at Montague City	- 28' and rising
Connecticut River at Hartford	- 19' and rising

* Telemark gaging stations. Check RCC directory for telephone numbers

c. Emptying the Reservoir. Emptying the reservoir will not be initiated until contact has been established with RCC.

35. COOPERATION WITH DOWNSTREAM WATER USERS

a. General. It is the policy of the Corps of Engineers to cooperate with downstream water users and other interested parties or agencies. The Manager may be requested by downstream users to deviate from normal regulation for short periods of time. Whenever a request for such modification is received, the Manager shall ascertain the validity of the request and require the individual making the request to obtain assurance from other downstream water users that they are agreeable to the proposed operation. The Manager will then relay the information to RCC and request instructions. A minimum release from both projects for downstream fish life shall always be maintained during periods of regulation.

b. Regulation for White Water Canoe Races. Organized racing on the Westfield River started in 1954 with less than 10 teams entered in the "Westfield Wild Water Race", sponsored by the Westfield Chamber of Commerce. It remained a small event until the early 1960's when the number of teams increased significantly. In recent years, race spectators have been estimated at 17,000 and entries have numbered approximately 1,000.

In order to accommodate this increased interest, flows have been regulated at Knightville since the middle 1960's and Littleville since the early 1970's. Reservoir releases for the races is limited to early April, as natural riverflows later often recede rapidly, and holding storage later than this could have an adverse impact on reservoir tree life and forest cover.

36. ABSENCE FROM DAM

RCC and the Basin Manager are notified whenever the Project Manager expects to be away from the dam either overnight or for an extended period.

37. SEDIMENTATION

Sedimentation ranges and movements have been installed in the Knightville reservoir area; however, experience at Knightville and all other Corps dry bed reservoirs in New England has shown that only minimal amounts of sedimentation can be expected.

Due to the size of the water supply pool at Littleville Lake, sedimentation will be monitored with the establishment of sedimentation ranges and monuments.

38. FUTURE STUDIES

Post flood studies will be made of each reservoir regulation period to determine efficiency of communications and reporting networks, applicability of regulation guides, including stage-discharge relationships, and discharge correlations and flood reductions at damage centers.

39. WATER QUALITY ACTIVITIES

There is no storage of water at Knightville or Littleville specifically for management or control of downstream water quality. Although water quality control is not an authorized project purpose, compliance with Executive Order 11752 requires that all Federal facilities shall be managed so as to protect and enhance the quality of water resources through compliance with applicable standards for the prevention, control and abatement of environmental pollution in full cooperation with State and local Governments.

Littleville Lake is equipped with a multilevel intake tower, the intended purpose of which is to control the temperature and/or dissolved oxygen content of water withdrawn for municipal supply by the city of Springfield, Massachusetts.

As stated in ER 1130-2-1334 and ER 1130-2-415, monitoring of reservoir inflows, impoundments and discharges is accomplished

on a scheduled basis. Data is collected for many physicochemical parameters and a limited number of bacteriological and biological parameters. Monitoring and analysis are under the administrative and management control of Operations Division. Summaries of their water quality analyses and activities are included in an annual report to OCE, as required under the provisions of ER 1130-2-334. Sampling and analysis of water quality is also being performed in the interest of public health associated with water supply and recreation activities at the projects in accordance with ER 1130-2-407 and other existing guidance.

A lake temperature simulation model (Edinger-Eiker) has been calibrated using temperature versus depth data collected at Littleville Lake.

CHAPTER VII

HYDROLOGIC EQUIPMENT

40. PRECIPITATION GAGE

Standard weighing and recording NWS precipitation gages have been installed at Knightville Dam and Littleville Lake. These gages serve as a supplement to other NWS rainfall stations within or in the vicinity of the Westfield River watershed.

Project Managers or their assistants should check these gages daily to determine if they are operating properly and also to record any precipitation occurrence in the last 24 hours.

41. RESERVOIR STAGE RECORDER

The automatic float-operated water level recorders at Knightville and Littleville trace the water level in the reservoirs at all times. Recording instruments should be checked each morning to assure the clock is keeping correct time and the pen is tracing properly. Any discrepancies in the record as evidenced by the pen time or gage heights should be noted on the chart, and the instrument reset. During periods of reservoir storage, the outside tile or staff gage should be read to check tape readings and/or chart records. Should the recorder become inoperable, the USGS should be notified and arrangements made to repair the instrument; RCC should also be notified.

The chart record should be changed the first working day of each month at both Knightville and Littleville and the following information noted in ink at the beginning and end of each chart:

Outside (tile) gage reading
Pen gage height reading
Watch time
Pen time
Date and name of dam

42. TAILWATER GAGING STATIONS

USGS gaging stations immediately downstream of each dam,

provide a continuous official record of releases from the projects. At Knightville a remote recorder transmits water levels from the tailwater gage to the dam. Both gages are equipped with digital-type water stage recorders and are operated and maintained under a cooperative stream gaging program. It is essential the gages be checked frequently to assure proper operation. If inspection indicates a need for repair, the USGS should be notified immediately and arrangements made to have the equipment repaired.

43. TELEPHONE TRANSMITTER (TELEMARK)

The telephone transmitters on the Westfield River at Westfield and the West Branch Westfield River at Huntington are used for regulation in the Westfield River watershed. The Project Manager of Littleville calls the gage at Westfield as part of the normal weekly report. Project Managers of Knightville and Littleville should call the gages at least once a month to retain familiarization with the reporting code. During failures of communications, the Westfield River projects must regulate for the Westfield USGS gage stages. Should a telemark become inoperable during the monthly check, the Littleville Project Manager should visit the gage. If the trouble cannot be determined, the telephone company should be requested to check their circuits in the presence of the Project Manager. If the telemark still is not functioning by this time, the USGS should be notified. Batteries for equipment at these gaging stations will be furnished and installed by the USGS.

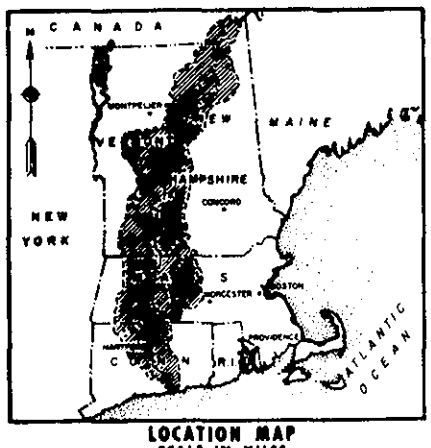
44. SNOW SAMPLING SET

A snow sampling set has been assigned to the Project Manager at Knightville. Snow surveys will be carried out by the Managers and assistants from both Knightville and Littleville. Procedures for obtaining snow survey data should follow instructions set forth in "Snow Sampling Guide, Department of Agriculture, Handbook 1960". If given proper care, the only maintenance required would be occasional replacement of wornout cutterheads.

Snow surveys will normally be conducted from 15 January to 15 April or as long as RCC considers necessary. Prior preparation by the Project Manager should include inspection of the snow survey equipment and reconnaissance of the snow survey courses.

Full snow surveys will generally take place every other week to

coincide with surveys by the Massachusetts Water Resources Commission, New Hampshire Water Resources Board and the New England Power Company. On alternate weeks, index snow surveys involving selected snow courses will be taken, to determine general conditions in the watershed. Locations of the snow courses in the Westfield watershed are shown on plate H-3. Table H-5 lists the location of the courses.



CONNECTICUT RIVER BASIN

SHEET 1 OF 2

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

SCALE IN MILES
4 0 4 8

JULY 1977

PLATE H-1

MATCH LINE

WESTON LOCAL PROT.

BALL MOUNTAIN DAM

TOWNSHEND DAM

SURRY MOUNTAIN DAM

OTTER BROOK DAM

TULLY DAM

BIRCH HILL DAM

GARDNER LOCAL PROT.

KNIGHTVILLE DAM

LITTLEVILLE DAM

HOLYOKE LOCAL PROT.

CHICOPEE LOCAL PROT.

CHICOPEE FALLS LOCAL PROT.

RIVERDALE LOCAL PROT.

SPRINGDALE LOCAL PROT.

NORTHAMPTON LOCAL PROT.

BARRE FALLS DAM

WARE LOCAL PROT.

WEST WARREN LOCAL PROT.

THREE RIVERS LOCAL PROT.

SPRINGFIELD LOCAL PROT.

CONANT BROOK DAM

COLEBROOK RIVER DAM

MAD RIVER DAM

SUCKER BROOK DAM

WEST SPRINGFIELD LOCAL PROT.

HARTFORD LOCAL PROT.

EAST HARTFORD LOCAL PROT.

ROCKINGHAM

N. WALPOLE

WESTMINSTER

WALPOLE

BRATTLEBORO

KEENE

MARLBORO

ASHUELOT

WINCHESTER

NORTHFIELD

GREENFIELD

W. DEERFIELD

MONTAGUE CITY

ATHOL

GARDNER

TEMPLETON

QUABBIN RESERVOIR

HATFIELD

HADLEY

NORTHAMPTON

EASTHAMPTON

HOLYOKE

CHICOPEE

WEST SPRINGFIELD

AGAWAM

SPRINGFIELD

MONSON

WARE

SPENCER

ENFIELD

WAREHOUSE PT.

WINDSOR LOCKS

RAINBOW

SOUTH WINDSOR

WILSON

HARTFORD

MANCHESTER

E. HARTFORD

COLLINSVILLE

W. HARTFORD

GLASTONBURY

BRISTOL

PLAINVILLE

NEW BRITAIN

ROCKY HILL

BERLIN

CROMWELL

PORTLAND

MIDDLETOWN

NEW LONDON

WATERFORD

NEW HAVEN

W. HAVEN

LONG ISLAND SOUND

M A S S A C H U S E T T S

C O N N E C T I C U T

N E W H A M P S H I R E

V E R M O N T

COMPLETED PROJECT

SMALL FLOOD CONTROL PROJECTS NOT SPECIFICALLY AUTHORIZED BY CONGRESS

RADIO GAGING STATION

CONNECTICUT RIVER BASIN

SHEET 2 OF 2

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

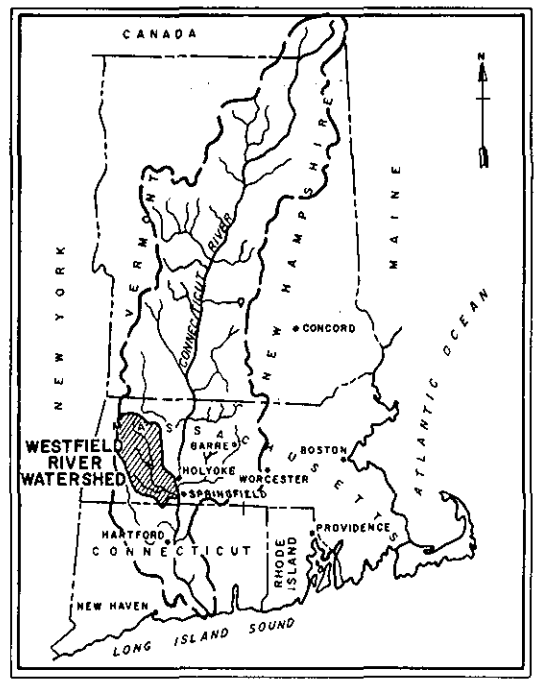
SCALE IN MILES
4 0 4 8

JULY 1977

PLATE H-2

CORPS OF ENGINEERS

U. S. ARMY



REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.

LEGEND

- STREAM GAGING STATION - U. S. G. S.
- STREAM GAGING STATION - N. W. S.
- PRECIPITATION GAGE
- N E D SNOW SURVEY SITE
- 5 RIVER MILE ABOVE CONFLUENCE WITH CONNECTICUT RIVER
- DIKE AND/OR FLOOD WALL
- CITY OR TOWN BOUNDARIES
- AGAWAM CITY OR TOWN

SCALE IN MILES
3 2 1 1/2 0 3

WATER RESOURCES DEVELOPMENT PROJECT

WESTFIELD RIVER WATERSHED

WATERSHED MAP

NEW ENGLAND DIVISION, WALTHAM, MASS.

AUGUST 1977

PLATE H-3

CORPS OF ENGINEERS

U. S. ARMY

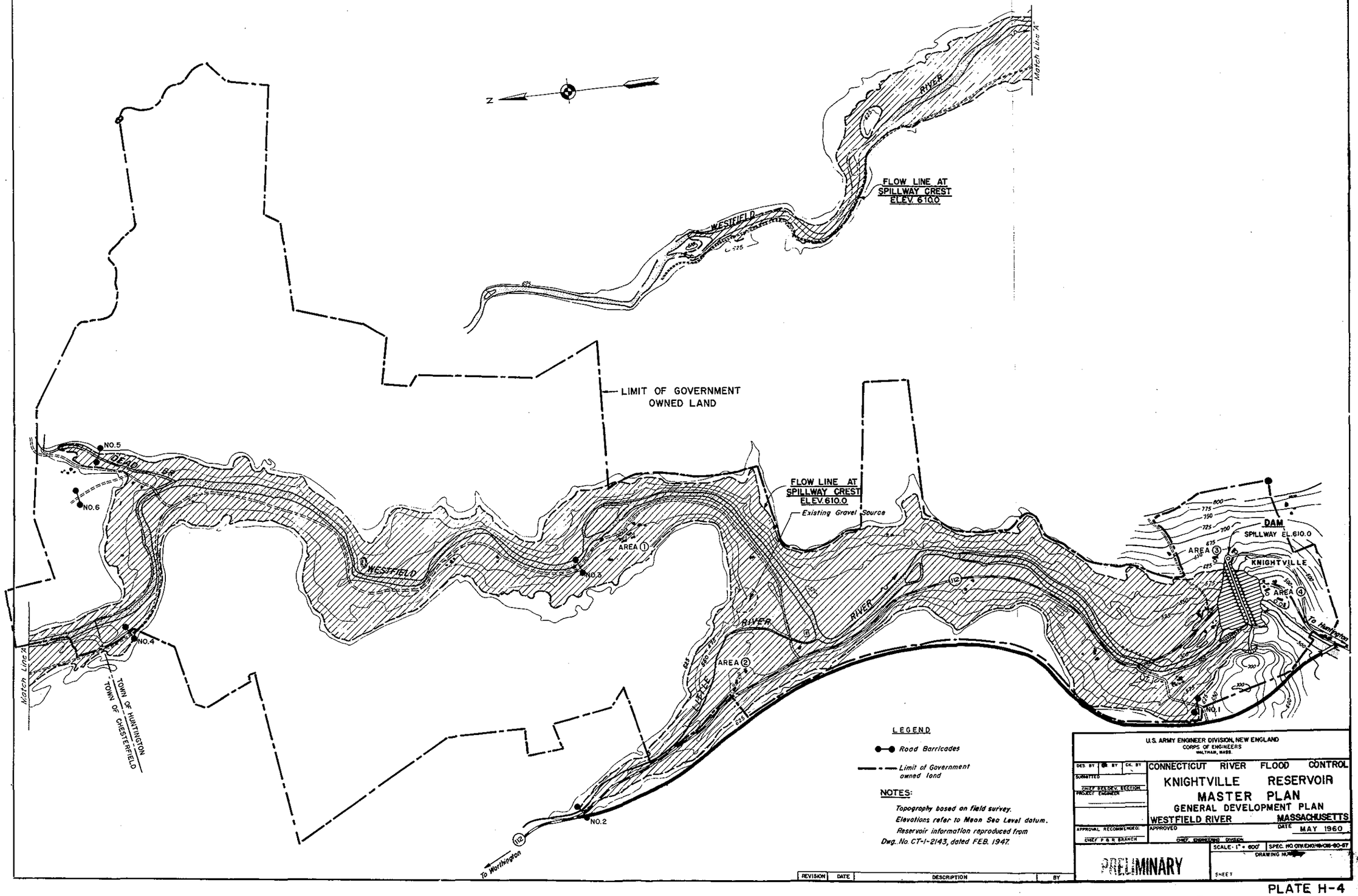
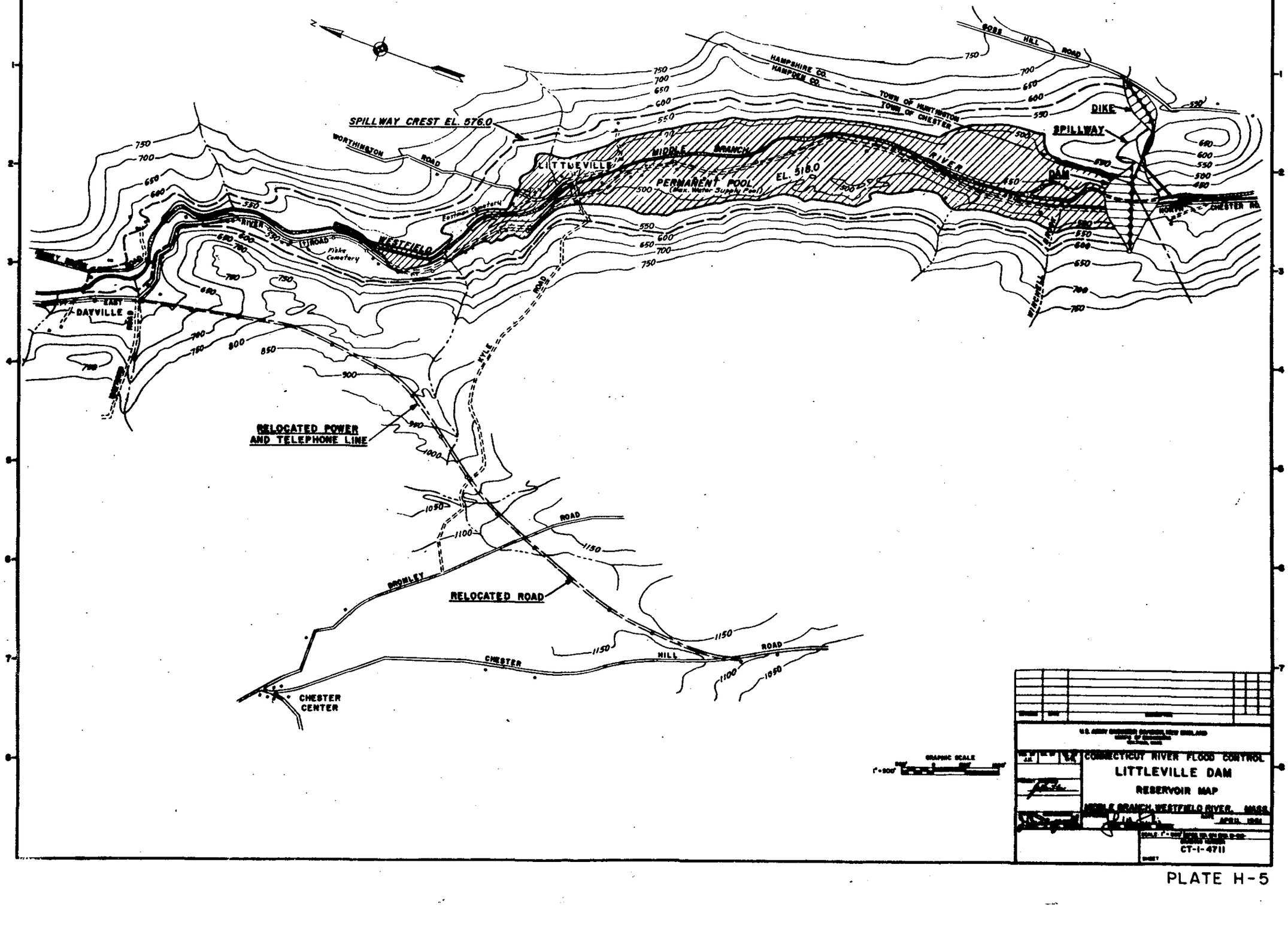


PLATE H-4

CORPS OF ENGINEERS — U.S. ARMY



COMMONWEALTH OF MASSACHUSETTS

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE DAM

RESERVOIR MAP

MIDDLE BRANCH WESTFIELD RIVER, MASS.

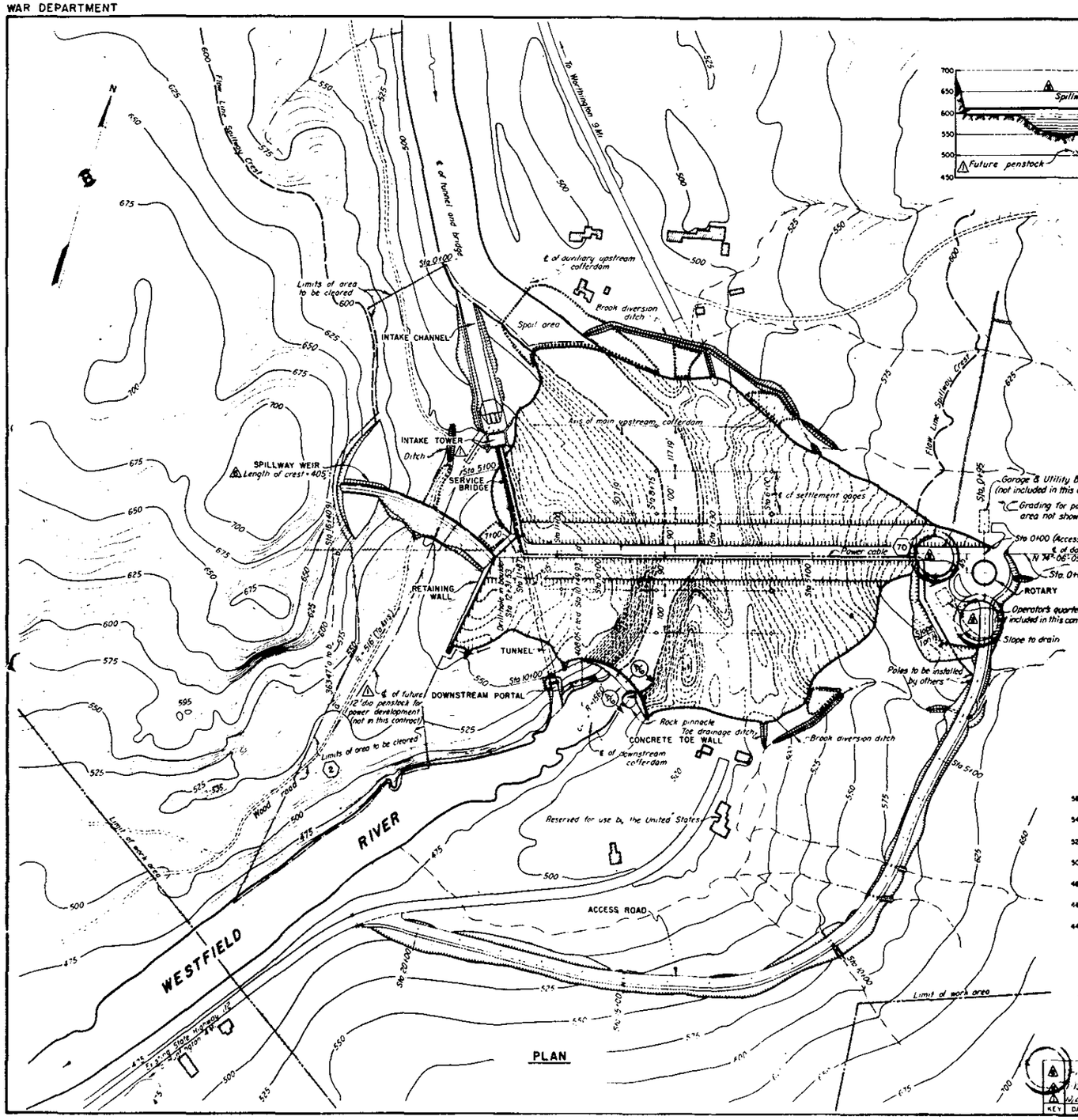
APRIL 1964

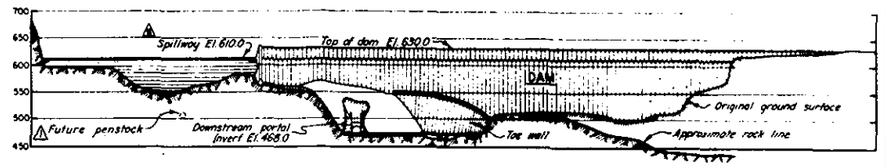
CT-1-4711

PLATE H-5

WAR DEPARTMENT

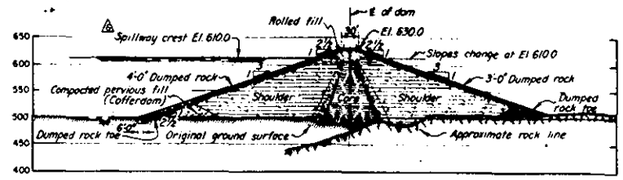
CORPS OF ENGINEERS, U S ARMY





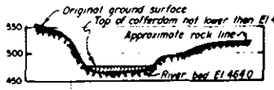
DOWNSTREAM ELEVATION OF DAM - DEVELOPED

NOT TO SCALE

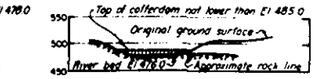


SECTION THRU DAM AT STA. 7+30

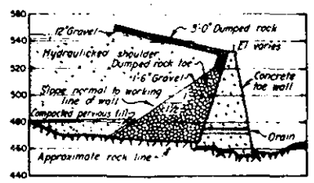
MAIN UPSTREAM COFFERDAM



DOWNSTREAM COFFERDAM



AUXILIARY UPSTREAM COFFERDAM



SECTION A-B

SCALE 1:40

NOTES

Elevations refer to Mean Sea Level Datum
Contour interval is five feet
Cofferdam profiles are taken looking upstream
• Type "A" settlement gage
• Type "B" settlement gage
Spoil areas

KEY	DATE	REVISION (Initials by)	REV BY	CK BY	AP BY
4	10-41	Power cable added			
3	13-41	Fill added for Operators quarters			
2	11-27-39	Spillway elevation revised			
1		Excavation added penstock revised			

CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE DAM
GENERAL PLAN

WESTFIELD RIVER MASSACHUSETTS

IN 8 SHEETS SCALE-IN = 100 FT SHEET NO 6

U S ENGINEER OFFICE, PROVIDENCE, R I. JAN 1939

SUBMITTED: SENIOR ENGINEER, HEAD DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER

APPROVED: CHIEF OF ENGINEERS

DESIGNED: ASSOC ENGINEER

DRAWN BY

TRACED BY

CHECKED BY

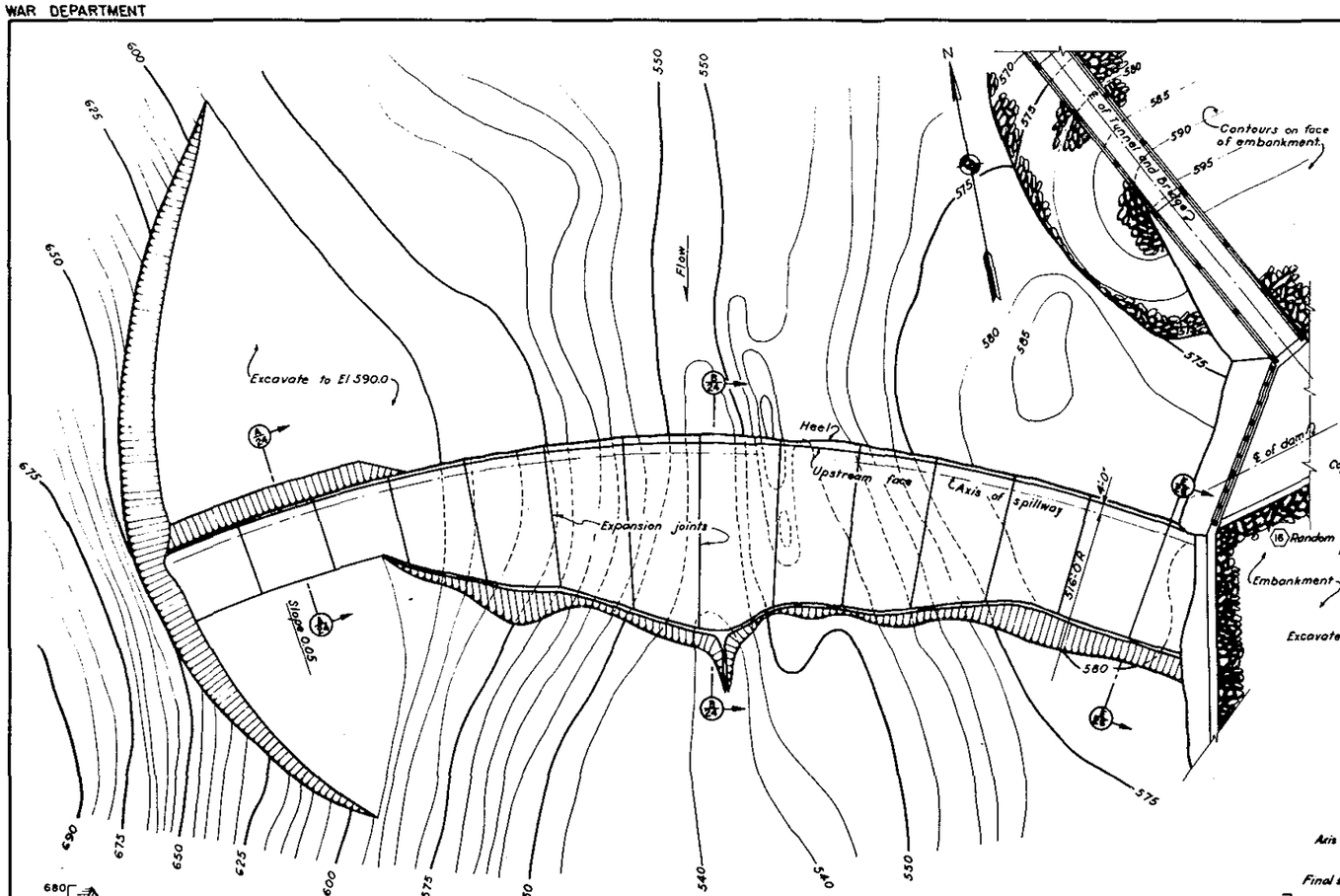
FILE NO

PRINTED Engineering Div.

PLATE H-6

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTES

Concrete in the spillway shall be Class "B". Payment made under Item No. 30.

No horizontal field joints shall be made in the spillway above El. 595.0 except as noted.

The depth of foundation excavation for the spillway weir determined in the field, and payment made under Item No. 9 for the actual quantities removed.

Figures in hexagons indicate item number under which payment made.

Concrete surface at all expansion joints shall be uncoated.

See Sheet No. 27 for details of V strips for all vertical expansion joints.

RECORD DRAWINGS

CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE DAM

SPILLWAY

WESTFIELD RIVER, MASSACHUSETTS

IN 33 SHEETS SCALE: 1 IN = 10 FT SHEET NO. 24

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., JAN. 1939

SUBMITTED: Chief, Design Section — APPROVAL RECOMMENDED: Principal Engineer — APPROVED: Lt. Col., Corps of Engineers, District Engineer

DESIGNED: Assoc. Engineer — DRAWN BY: W.B.M. — TRACED BY: J.B. — CHECKED BY: —

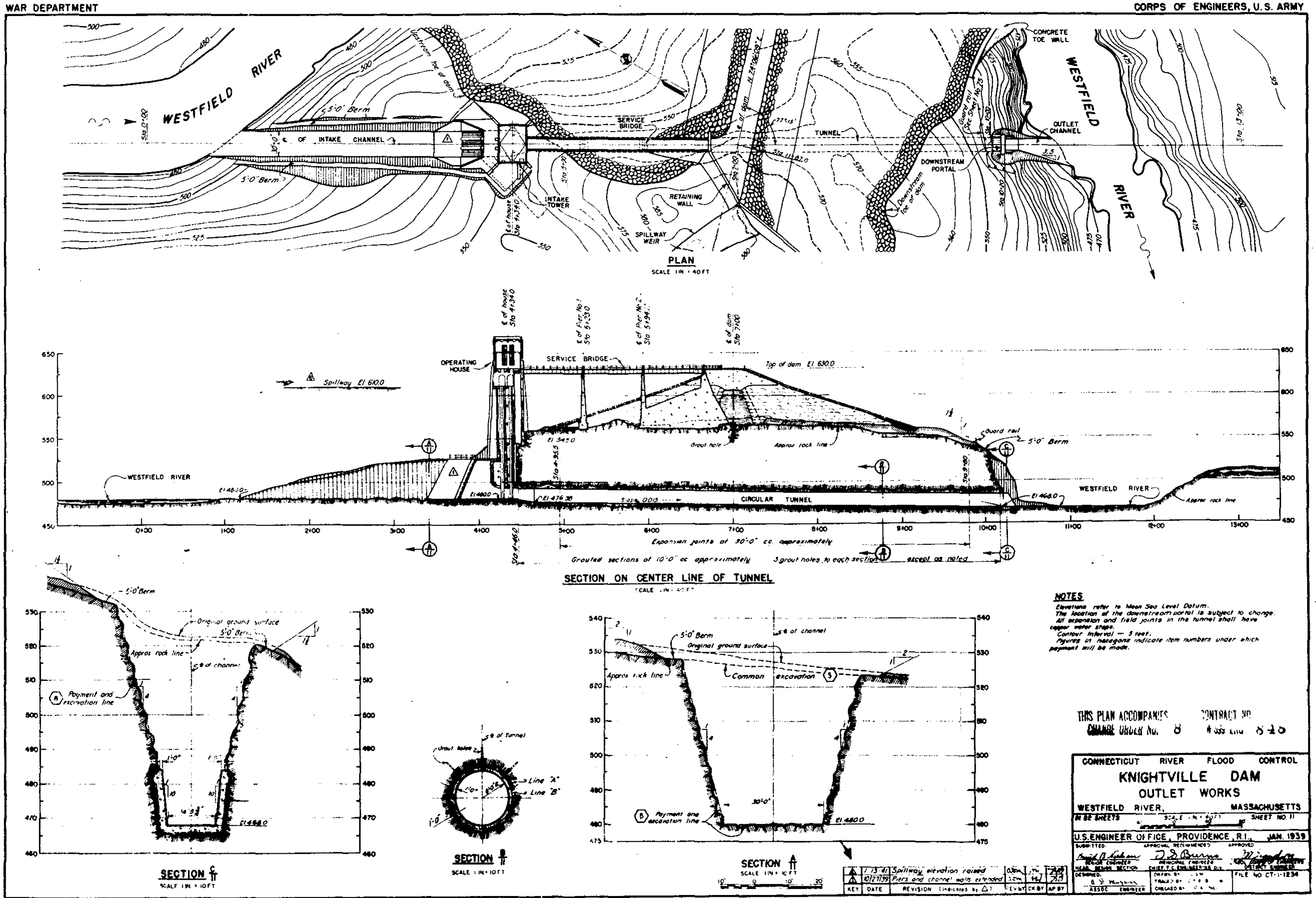
FILE NO. CT 1-1261

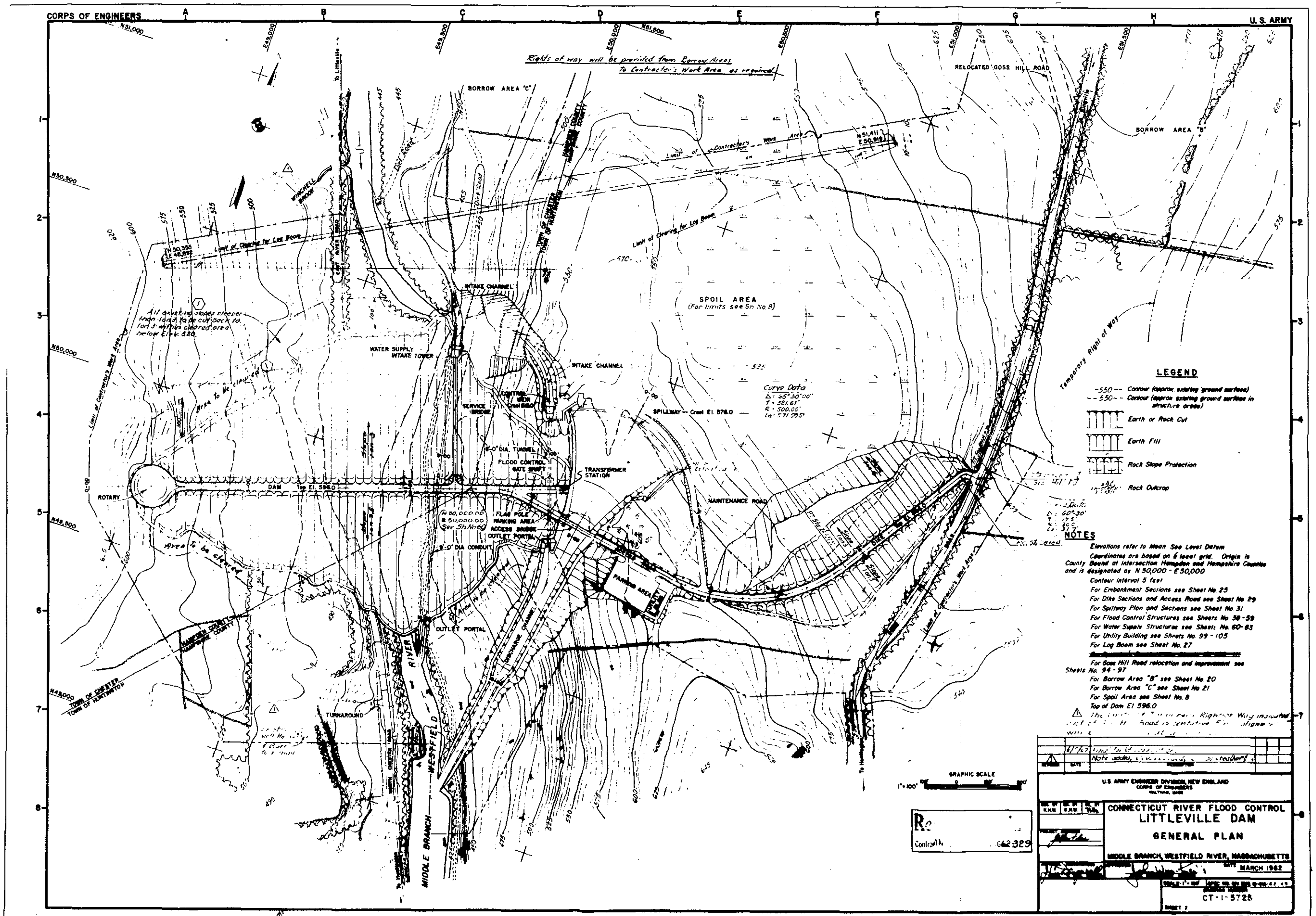
KEY	DATE	REVISIONS (Indicated by △)	DRN. BY	CK BY	AP BY
⚠	1-13-41	Spillway elevation raised			

PLATE H-7

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY

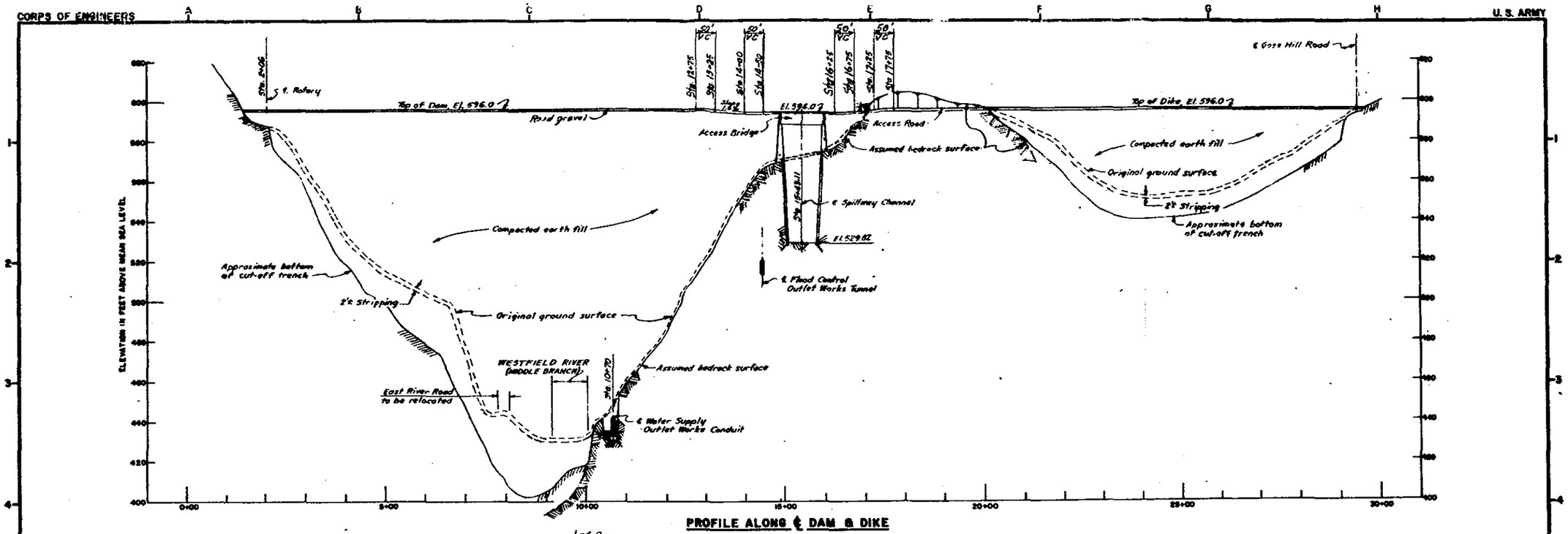




CORPS OF ENGINEERS
U. S. ARMY
Rights of way will be provided from Borrow Areas To Contractor's Work Area as required
BORROW AREA "C"
RELOCATED GOSS HILL ROAD
BORROW AREA "B"
Limit of Clearing for Log Boom
WINCHELL BROOK
INTAKE CHANNEL
SPOIL AREA
(For limits see Sh. No. 8)
WATER SUPPLY INTAKE TOWER
SERVICE BRIDGE
SPILLWAY — Crest El 576.0
TRANSFORMER STATION
FLOOD CONTROL GATE SHAFT
ROTARY
DAM Top El 596.0
MAINTENANCE ROAD
FLAG POLE
PARKING AREA
ACCESS BRIDGE
OUTLET PORTAL
PARKING AREA
TURNAROUND
MIDDLE BRANCH — WESTFIELD RIVER
TOWN OF CHESTER
TOWN OF HUNTINGTON
Temporary Right of Way
LEGEND
Contour (approx. existing ground surface)
Contour (approx. existing ground surface in structure areas)
Earth or Rock Cut
Earth Fill
Rock Slope Protection
Rock Outcrop
NOTES
Elevations refer to Mean Sea Level Datum
Coordinates are based on a local grid. Origin is County Bound at intersection Hampden and Hampshire Counties and is designated as N 50,000 - E 50,000
Contour interval 5 feet
For Embankment Sections see Sheet No. 25
For Dike Sections and Access Road see Sheet No 29
For Spillway Plan and Sections see Sheet No. 31
For Flood Control Structures see Sheets No 38 - 59
For Water Supply Structures see Sheets No. 60 - 83
For Utility Building see Sheets No. 99 - 105
For Log Boom see Sheet No. 27
For Goss Hill Road relocation and improvement see Sheets No. 94 - 97
For Borrow Area "B" see Sheet No. 20
For Borrow Area "C" see Sheet No 21
For Spoil Area see Sheet No. 8
Top of Dam El 596.0
GRAPHIC SCALE
1" = 100'
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
GENERAL PLAN
MIDDLE BRANCH, WESTFIELD RIVER, MASSACHUSETTS
MARCH 1962
CT-1-5725

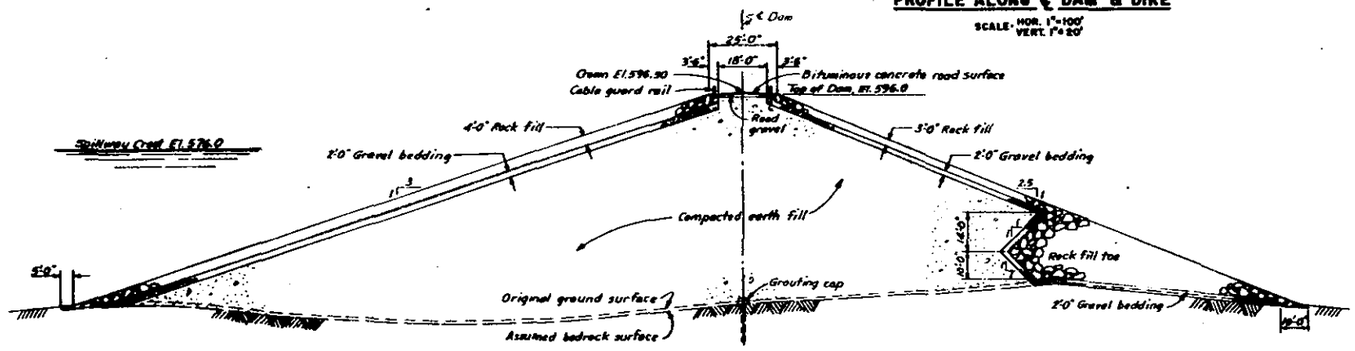
PLATE H-9

CORPS OF ENGINEERS — U. S. ARMY



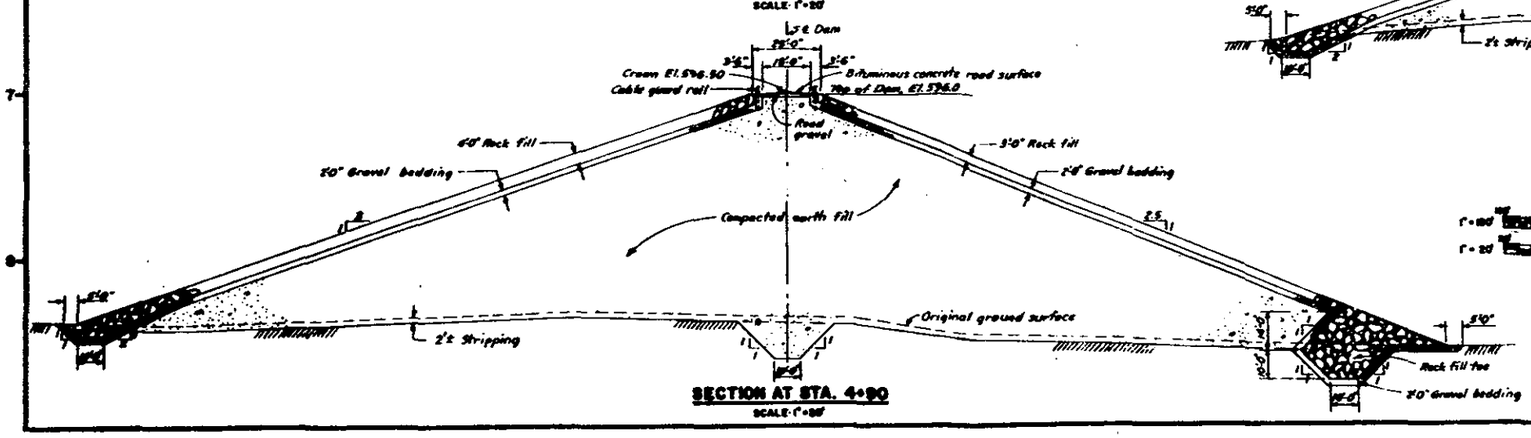
PROFILE ALONG ℄ DAM & DIKE

SCALE: HOR. 1"=100' VERT. 1"= 20'



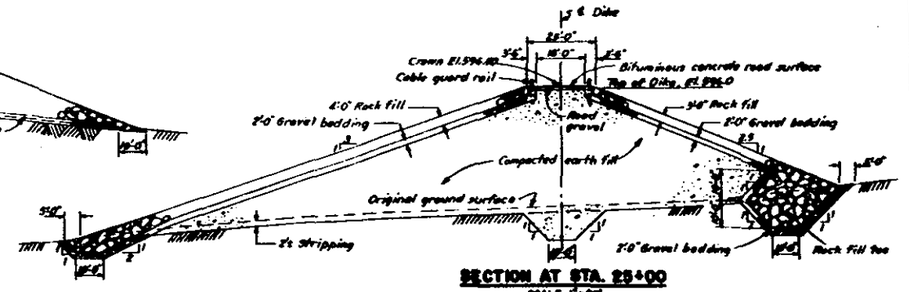
SECTION AT STA. 12+90

SCALE: 1"=20'



SECTION AT STA. 4+90

SCALE: 1"=20'



SECTION AT STA. 28+00

SCALE: 1"=20'

GRAPHIC SCALES

1"=100'

1"=20'

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE DAM

DAM AND DIKE

PROFILE AND SECTIONS

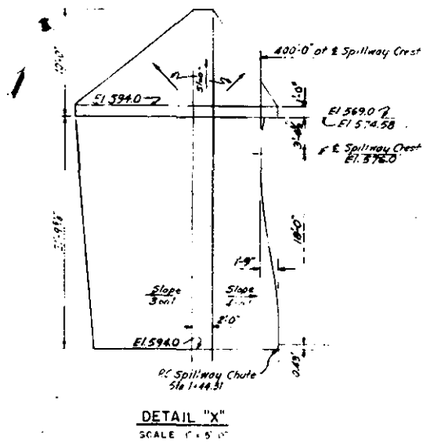
MIDDLE BRANCH WESTFIELD RIVER, MASS.

APRIL 1961

CT-1-4713

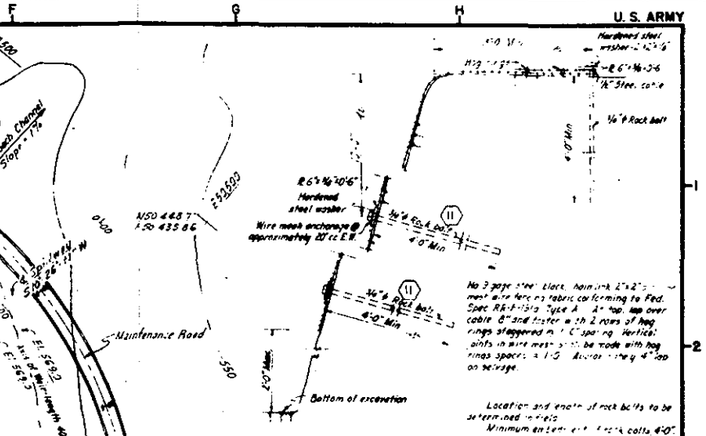
PLATE H-10

CORPS OF ENGINEERS — U.S. ARMY



DETAIL "X"
SCALE 1" = 5'-0"

PLAN
SCALE 1" = 40'



CHAIN LINK WIRE SAFETY MESH (11)
SLOPE PROTECTION
SCALE 1" = 1'-0"

NOTES:

Elevations refer to Mean Sea Level Datum.
For embankment sections, see Sheet No. 25.
For profile along ℄ of spillway channel and channel sections, see Sheet No. 32.
Figures in brackets indicate item numbers under which payment will be made.
Coordinates are based on a local grid. Origin is county bound at intersection of Hampden and Hampshire Counties and is designated as N 50,000 - E 50,000
For maintenance road sections, details, profile and turnaround see Sheet No. 98.

Recommending
Contract No. DA 19-016 CIV ENG 62329

REVISIONS	DATE	
6	7-2	Final field corrections

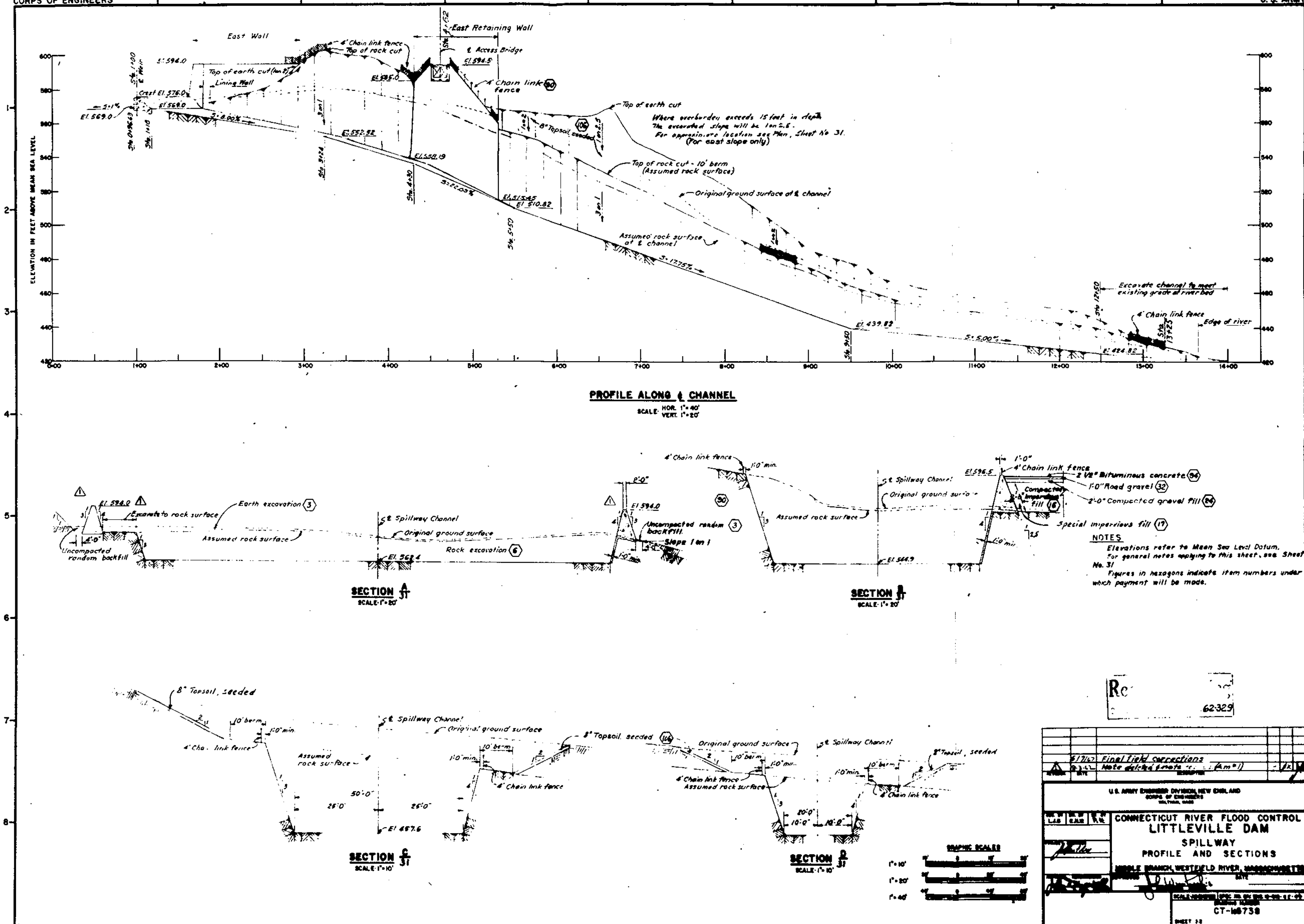
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DESIGNED BY L.A.B. | DRAWN BY K.A.H. | CHECKED BY W.W.

SHAPING SCALES
1" = 40'
1" = 1'-0"

CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
SPILLWAY
PLAN AND SECTIONS
MIDDLE BRANCH WESTFIELD RIVER, MASSACHUSETTS
DATE MARCH 1962
SCALE AS SHOWN
CT-1-5757
SHEET 31

PLATE H-11



CORPS OF ENGINEERS — U.S. ARMY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS

CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
SPILLWAY
PROFILE AND SECTIONS
MIDDLE BRANCH, WESTFIELD RIVER, MASSACHUSETTS

CT-16738

PLATE H-12

CORPS OF ENGINEERS

U.S. ARMY

SECTION A-A
SCALE: 1"=20'

PLAN
SCALE: 1"=80'

PROFILE ALONG ℄
SCALE: 1"=20'

NOTES:
For general notes applying to this sheet, see Sheet No. 2
Figures in hexagons indicate item numbers under which payment will be made
Top soil and seed all earth cut slopes

REVISION	DATE	DESCRIPTION
		E.O. Final Field corrections

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
FLOOD CONTROL OUTLET WORKS
PLAN AND PROFILE
MIDDLE BRANCH, WESTFIELD RIVER, MASSACHUSETTS

Contract No. DACW33-69-C-EXC62-329

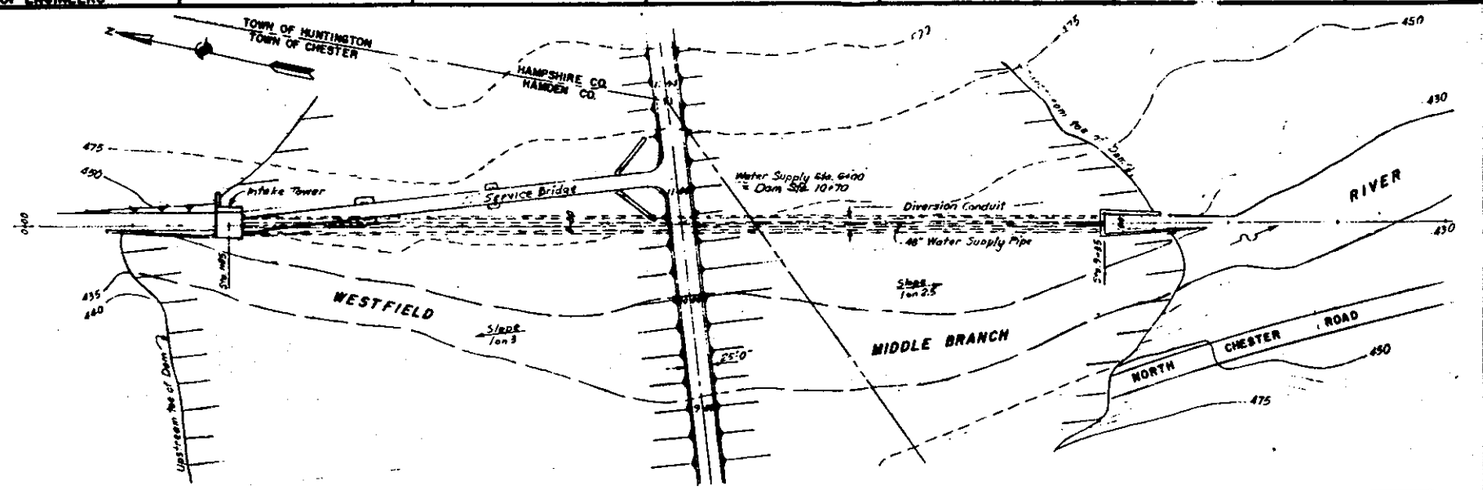
SCALE 1"=20'

DRAWING NUMBER
CT-I-5744

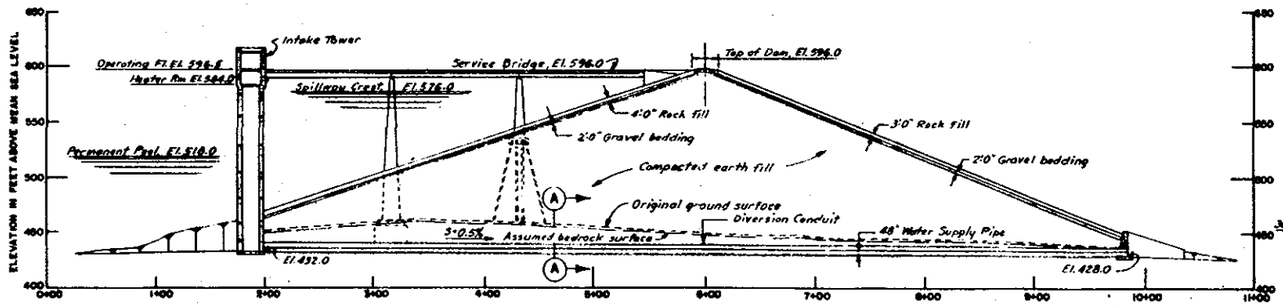
SHEET 38

PLATE H-13

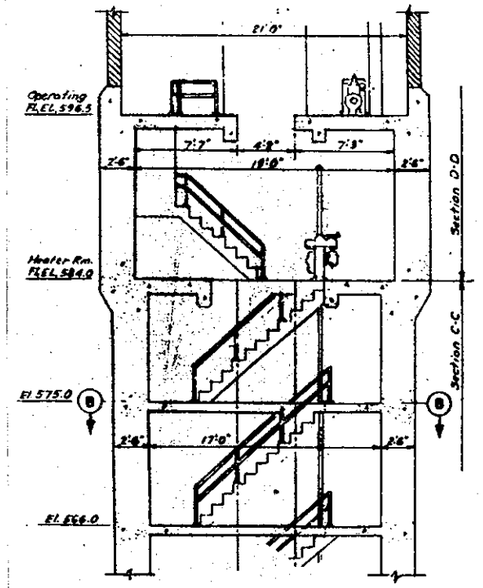
CORPS OF ENGINEERS — U.S. ARMY



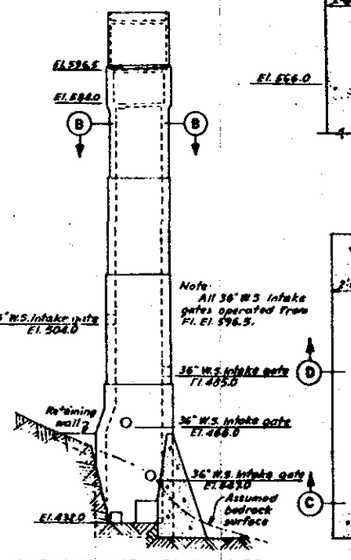
PLAN
SCALE: 1"=90'



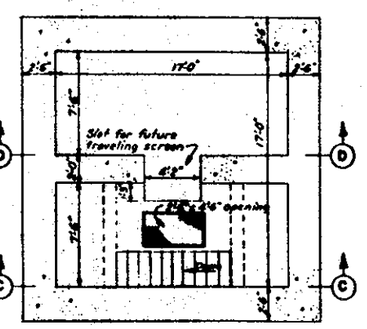
PROFILE ALONG ℄ CONDUIT
SCALE: 1"=90'



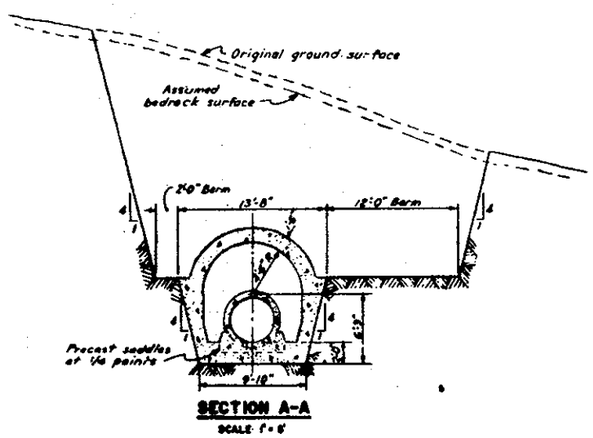
SECTION C-C & D-D
SCALE: 1/8"=1'-0"



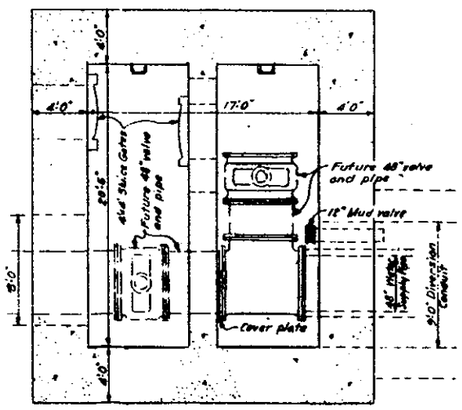
ELEVATION OF INTAKE TOWER
SCALE: 1"=30'



SECTION B-B
SCALE: 1/4"=1'-0"



SECTION A-A
SCALE: 1"=5'



SECTION AT EL. 443.0
SCALE: 1/4"=1'-0"

GRAPHIC SCALES
1"=90'
1"=30'
1"=5'
1/4"=1'-0"

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

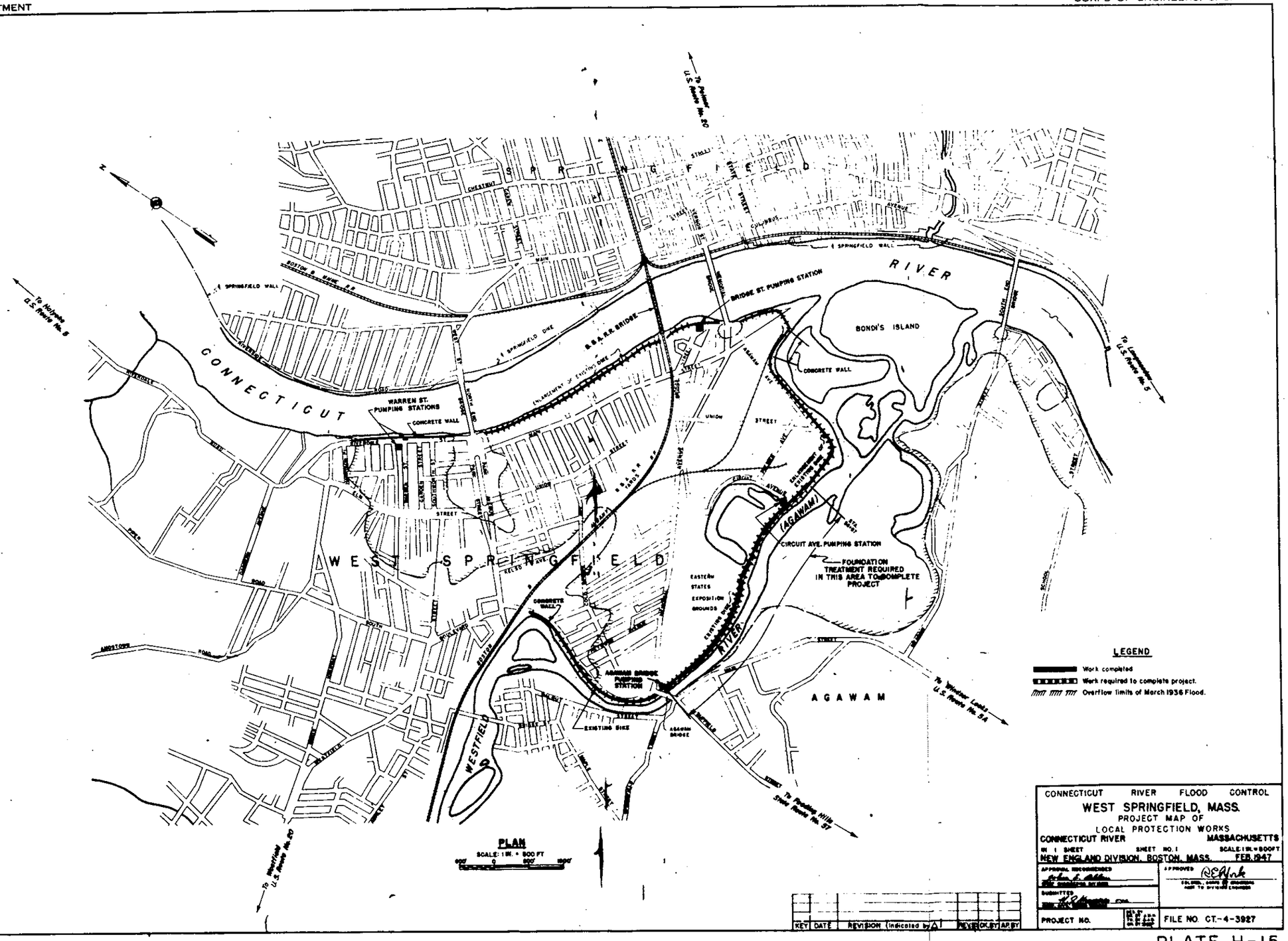
CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
WATER SUPPLY OUTLET WORKS
PLAN, PROFILE AND SECTIONS
MIDDLE BRANCH WESTFIELD RIVER, MASS.
APRIL 1954

CT-1-4717

PLATE H-14

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



KEY	DATE	REVISION (indicated by △)	REVISED BY	APP'D BY

CONNECTICUT RIVER FLOOD CONTROL

WEST SPRINGFIELD, MASS.

PROJECT MAP OF

LOCAL PROTECTION WORKS

CONNECTICUT RIVER MASSACHUSETTS

IN 1 SHEET SHEET NO. 1 SCALE: 1 IN. = 800 FT

NEW ENGLAND DIVISION, BOSTON, MASS. FEB. 1947

APPROVAL RECOMMENDED

DIV. ENGINEER, NEDIV.

APPROVED

COL., CORPS OF ENGINEERS
CHIEF OF ENGINEERS

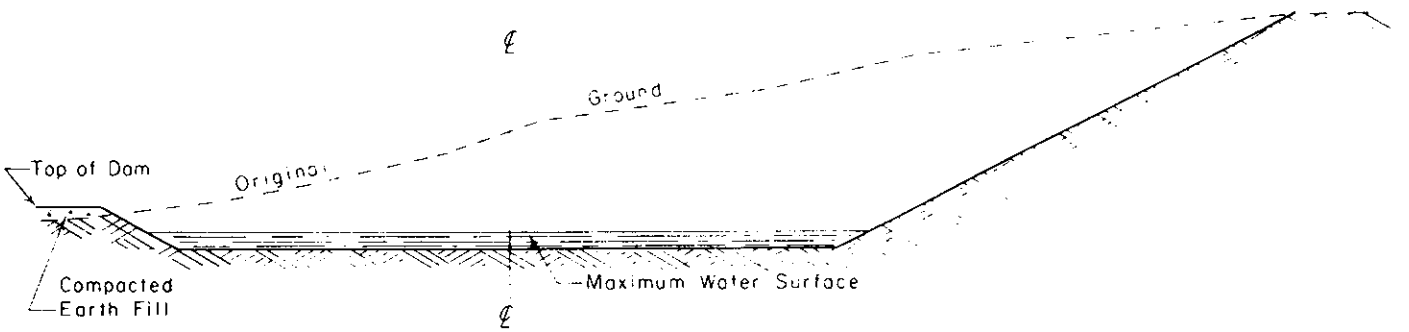
SUBMITTED

CHIEF, PLANNING BRANCH, CONS.

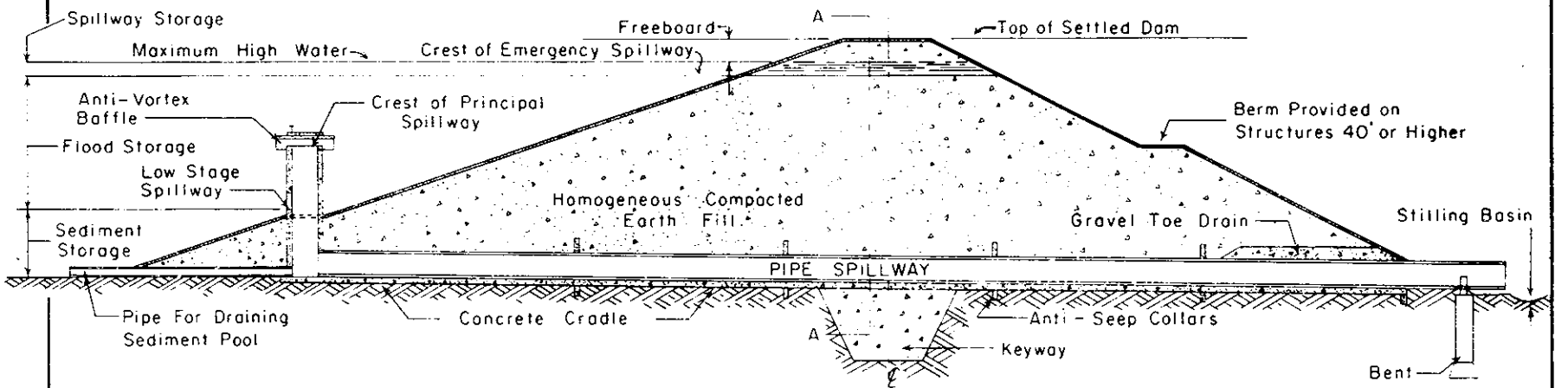
PROJECT NO.

FILE NO. CT.-4-3927

PLATE H-15

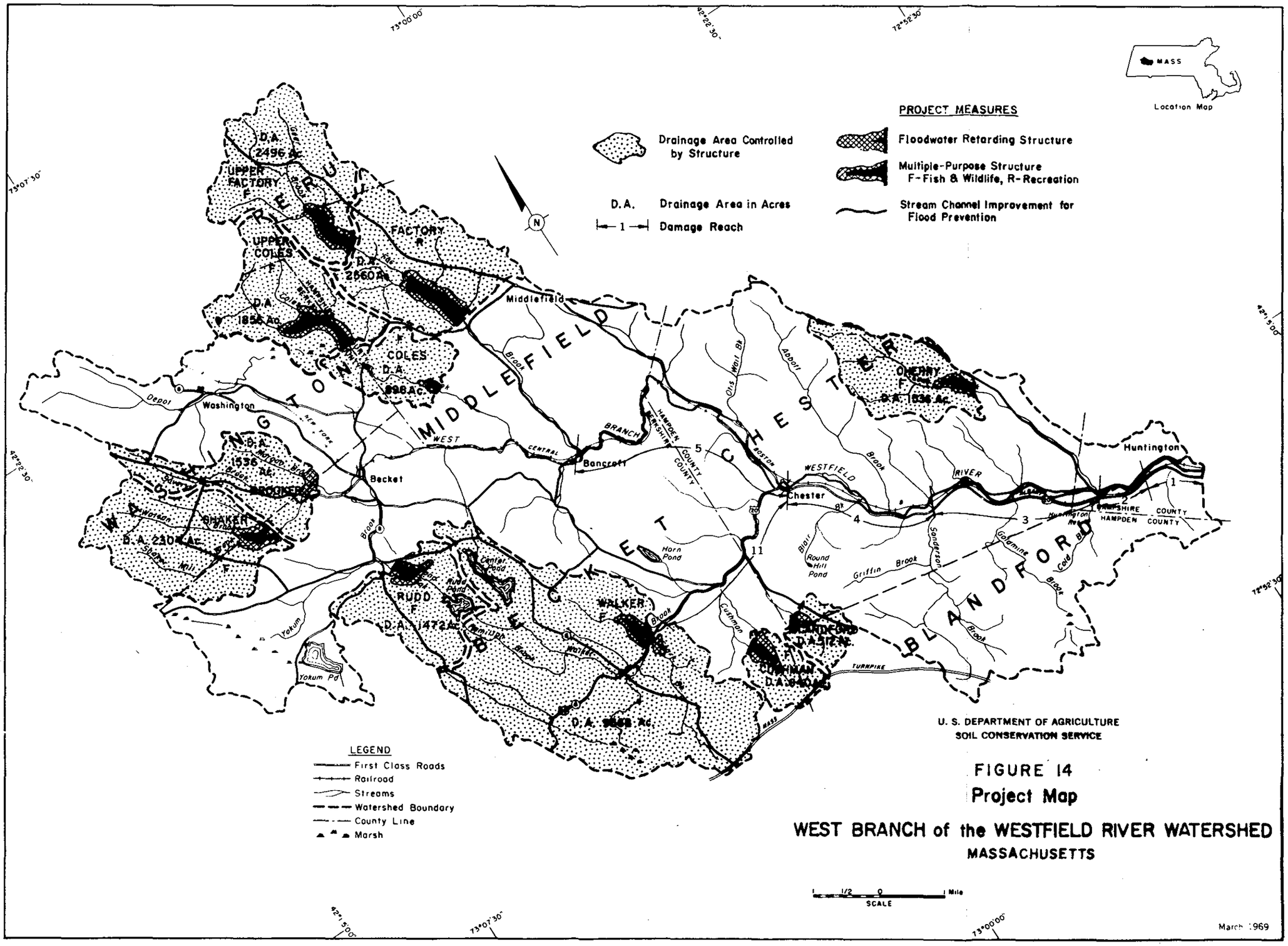


SECTION A-A
CROSS SECTION OF EMERGENCY SPILLWAY
CONTROL SECTION



TYPICAL CROSS SECTION OF FLOODWATER RETARDING STRUCTURE
ALONG PRINCIPAL AND EMERGENCY SPILLWAYS
U.S. SOIL CONSERVATION SERVICE

PLATE H-16



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FIGURE 14
Project Map

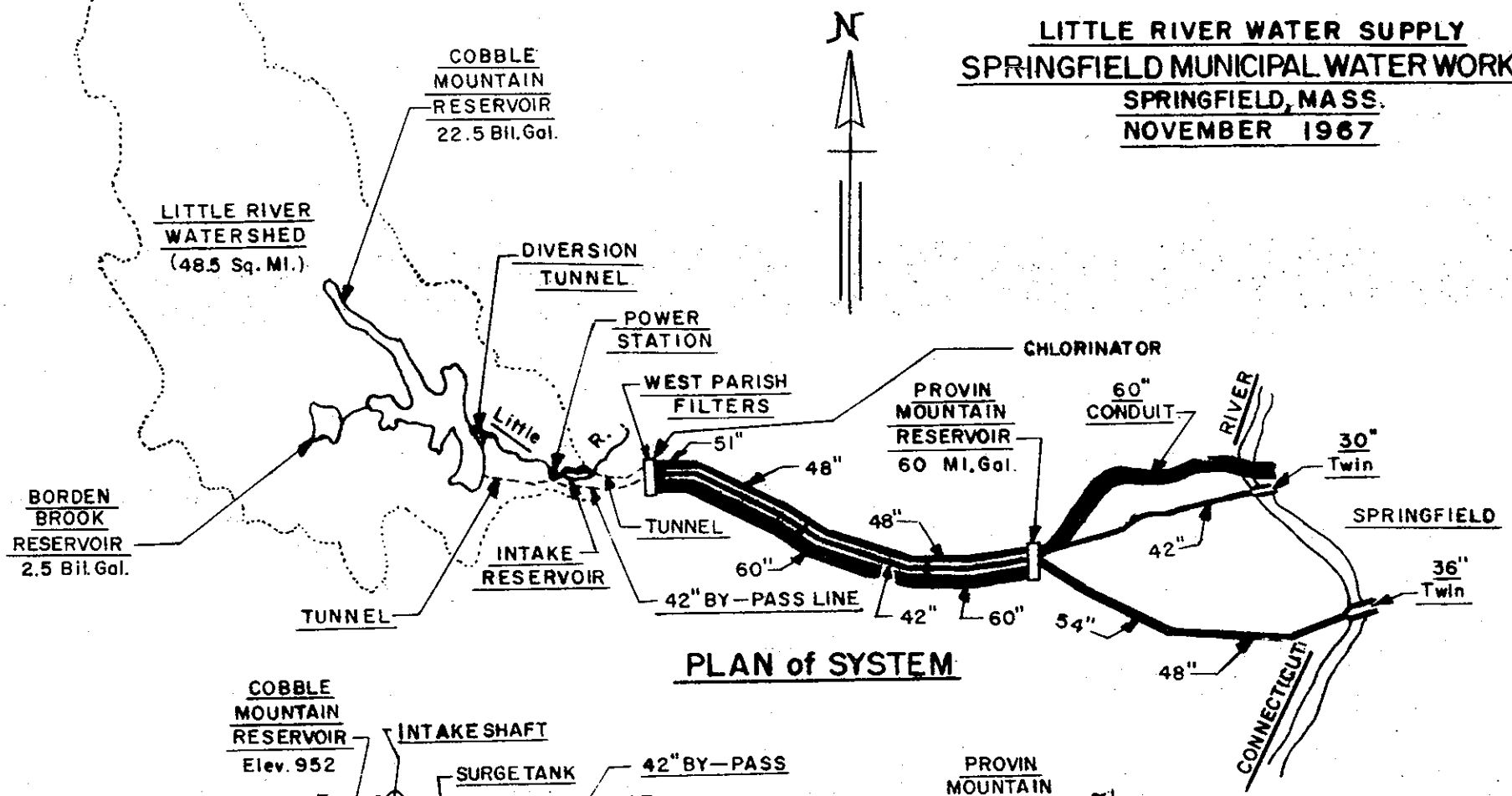
WEST BRANCH of the WESTFIELD RIVER WATERSHED
MASSACHUSETTS

March 1969

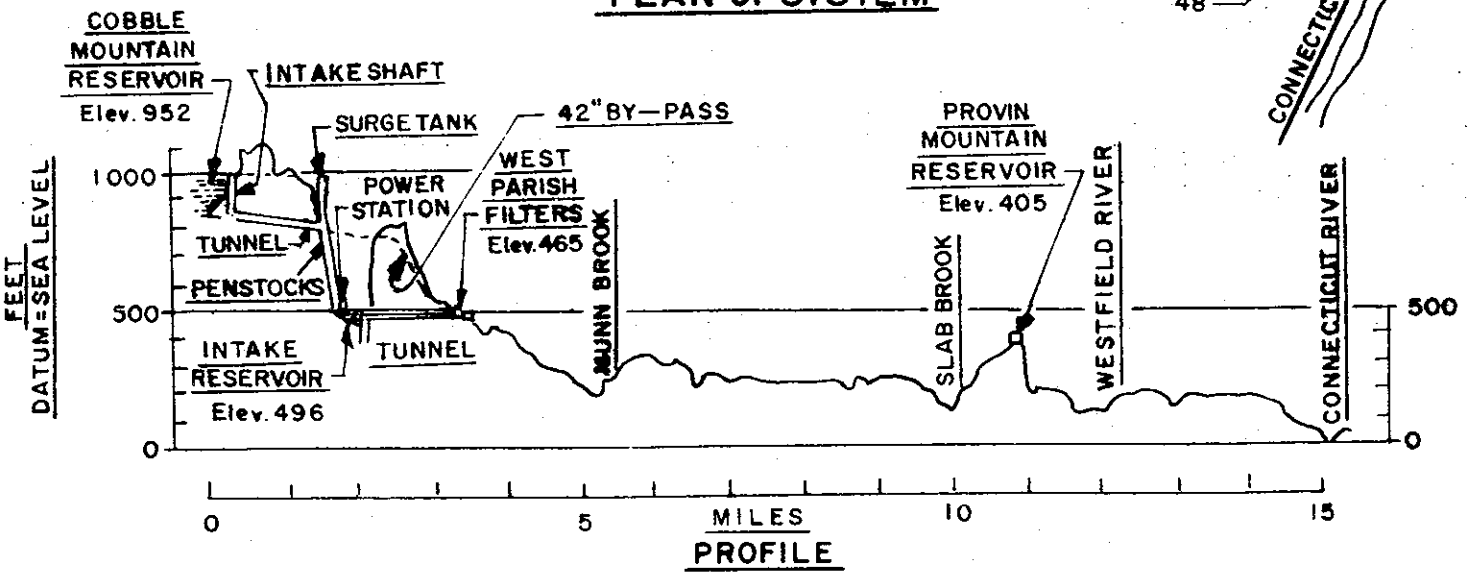
USDA-SCS-HYATTSVILLE, MD. 1969

PLATE H-17

LITTLE RIVER WATER SUPPLY
SPRINGFIELD MUNICIPAL WATER WORKS
SPRINGFIELD, MASS.
NOVEMBER 1967



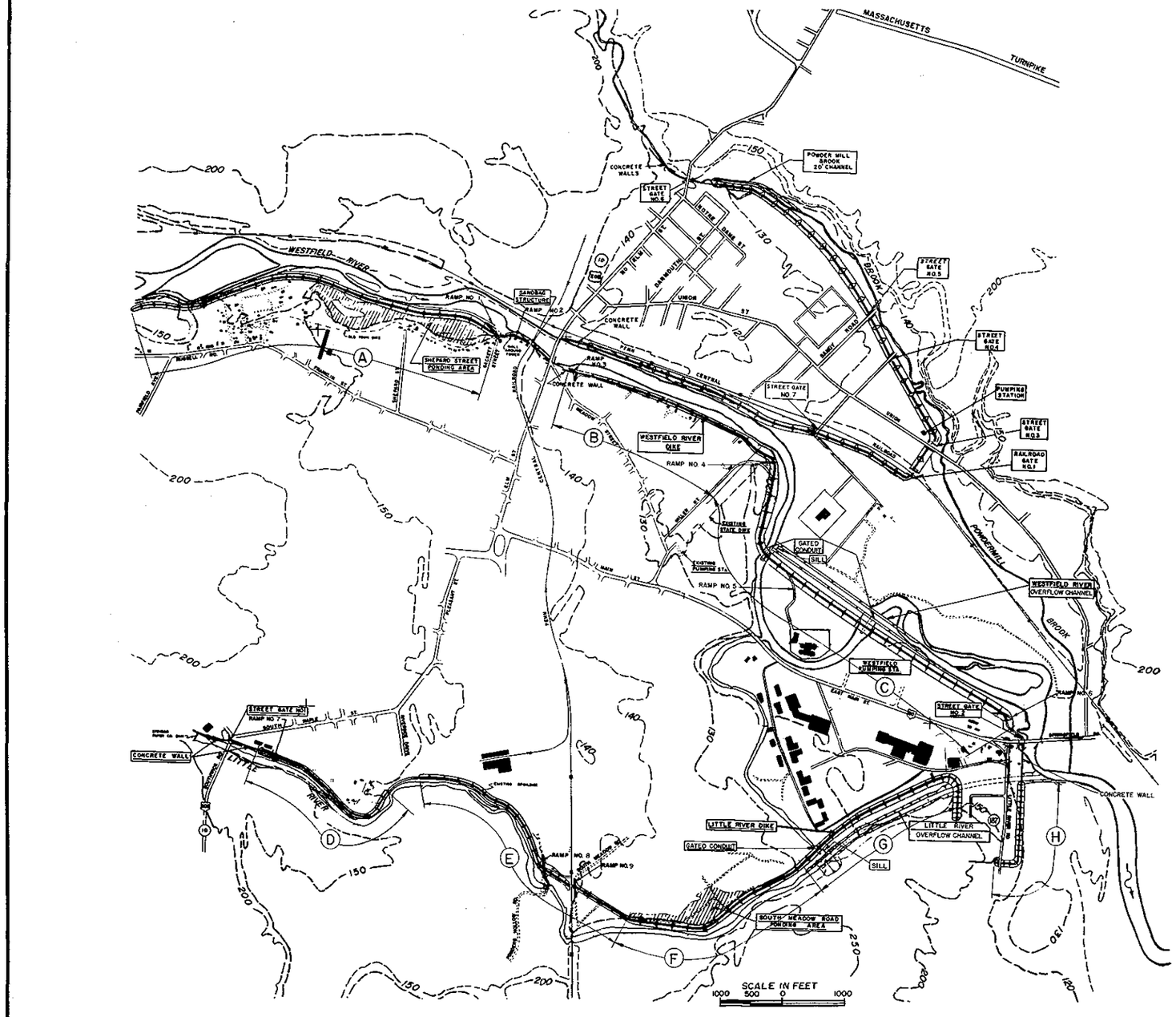
PLAN of SYSTEM

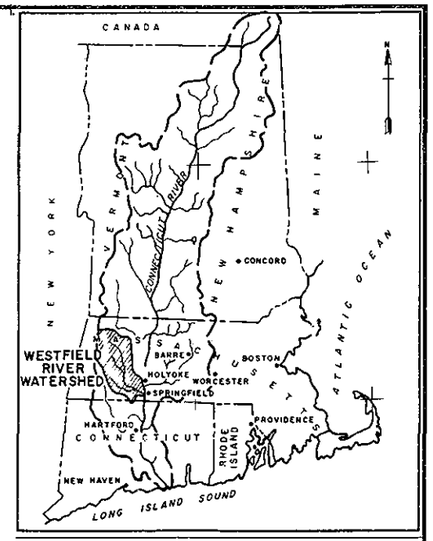


PROFILE

PLATE H-18

CORPS OF ENGINEERS





REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.

LEGEND

EARTH DIKE

CONCRETE FLOODWALL

PROPOSED
WESTFIELD LOCAL PROTECTION
GENERAL PLAN
JULY 1977

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE H-19

WATER CONTROL BRANCH
S. COOPER, CHIEF

RESERVOIR CONTROL CENTER
J. FINEGAN, CHIEF

HOUSATONIC RIVER BASIN
R. F. DOHERTY, BASIN REGULATOR

- THOMASTON DAM — A. HOFFMAN, PROJ. MGR. / R. M. HOWE, ASSISTANT
- HALL MEADOW BROOK DAM *
- EAST BRANCH DAM *
- NORTHFIELD BROOK LAKE
- HANCOCK BROOK LAKE
- HOP BROOK LAKE — L. WILLIAMS, PROJ. MGR. / J. DELONG, ASSISTANT
- BLACK ROCK LAKE — E.W. FOSTER, PROJ. MGR. / J. COLLINS, ASSISTANT

CONNECTICUT RIVER BASIN
R. W. MIRICK, UPPER REGULATOR
N. R. FORBES, LOWER REGULATOR

- UNION VILLAGE DAM — R. THRESHER, PROJ. MGR. / G. PARKER, ASSISTANT
- NORTH HARTLAND LAKE — J. W. WARD, PROJ. MGR. / J. DYER, ASSISTANT
- NORTH SPRINGFIELD LAKE — T. COEN, PROJ. MGR. / R. WITHINGTON, ASSISTANT
- BALL MOUNTAIN LAKE — H. C. LOBDELL, PROJ. MGR. / R. SNOW, ASSISTANT
- TOWNSHEND LAKE — R. BALLANTINE, PROJ. MGR / N. GOODENOUGH, ASSIST.
- SURRY MOUNTAIN LAKE — V. GUYETTE, PROJ. MGR. / R. TETREAULT, ASSIST.
- OTTER BROOK LAKE — J. BOYEA, PROJ. MGR. / D. SHEPARDSON, ASSISTANT
- BIRCH HILL DAM — J. BACON, PROJ. MGR. / C. SABINE, ASSISTANT
- TULLY LAKE — R. A. PARKER, PROJ. MGR. ASSISTANT
- BARRE FALLS DAM — L. BURGESS, PROJ. MGR. / G. BOWSE, ASSISTANT
- CONANT BROOK DAM
- LITTLEVILLE LAKE — J. PARKER, PROJ. MGR. / M. CAPUTO, ASSISTANT
- KNIGHTVILLE DAM — L.W. LAFOND, PROJ. MGR. / J. JOHNSON, ASSISTANT
- COLEBROOK RIVER LAKE — P.R. LEWIS, PROJ. MGR. / D. GREENE, ASSISTANT
- MAD RIVER DAM *
- SUCKER BROOK DAM *

THAMES RIVER BASIN
T. O. BUCKELEW, BASIN REGULATOR

- MANSFIELD HOLLOW LAKE — W HAWTHORNE, PROJ. MGR. / D. WARREN, ASSISTANT
- BUFFUMVILLE LAKE — J. B. HAY, PROJ. MGR. / R. FREYTAG, ASSISTANT
- HODGES VILLAGE DAM — D. W. CLARK, PROJ. MGR. ASSISTANT
- EAST BRIMFIELD LAKE — L. J. ROBERTS, PROJ. MGR. ,ASSISTANT
- WESTVILLE LAKE — W. T. SMITH, PROJ. MGR. / R. J. TRYBA, ASSISTANT
- WEST THOMPSON LAKE — C. A. BUSWELL, PROJ. MGR. / E. GLASS, ASSISTANT

BLACKSTONE RIVER BASIN
R. F. DOHERTY, BASIN REGULATOR

- WEST HILL DAM — J. M. CLARKIN, PROJ. MGR.

MERRIMACK RIVER BASIN
G. A. LARAWAY, BASIN REGULATOR

- FRANKLIN FALLS DAM — R. D. MAYO, PROJ. MGR. / O. LAROCHE, ASSIST.
- BLACKWATER DAM — J. ROBERTS, PROJ. MGR.
- EDWARD MACDOWELL DAM — J. RATHBURN, PROJ. MGR. / K. B. WETHERBEE, ASSIST.
- HOPKINTON LAKE — R. A. GOLEC, PROJ. MGR. / E. P. MCCABE, ASSISTANT
- EVERETT LAKE — J. A. PLIFKA, PROJ. MGR. / W. TURNER, ASSISTANT

HURRICANE BARRIERS
J. FINEGAN, REGULATOR

- NEW BEDFORD BARRIER — J. J. ARRUDA, PROJ. MGR. / F. M. CALDWELL, ASSIST.
- STAMFORD BARRIER — J. KATSURANIS, PROJ. MGR.
- FOX POINT BARRIER — ADVISORIES TO PROVIDENCE R. I. PUBLIC WORKS DEPT.
- PAWCATUCK, CONN. — ADVISORIES TO POLICE CHIEF.

RCC ASSISTANTS
P. E. HETU

WCB ASSISTANTS
D. P. BUELOW
P. J. BURNS
O. L. DONATI
T. M. FEENEY
J. A. LAMPARA
E. L. MAYNARD
R. P. MICHIELLUTTI
S. D. PARKER
C. J. WENER
P. A. MATTSON
H. F. MCMILLAN

RESERVOIR MANAGERS	
R. MORGAN	HOUSATONIC R. BASIN
S. ALEXANDER	THAMES R. BASIN
A. SAWICKI	MERRIMACK R. BASIN
E. MORSE	CONN. R. BASIN (UPPER)
J. LEDGERE	CONN. R. BASIN (LOWER)

ORGANIZATION CHART FOR RESERVOIR REGULATION

DIVISION ENGINEER
ENGINEERING DIVISION
WATER CONTROL BRANCH
RESERVOIR CONTROL CENTER

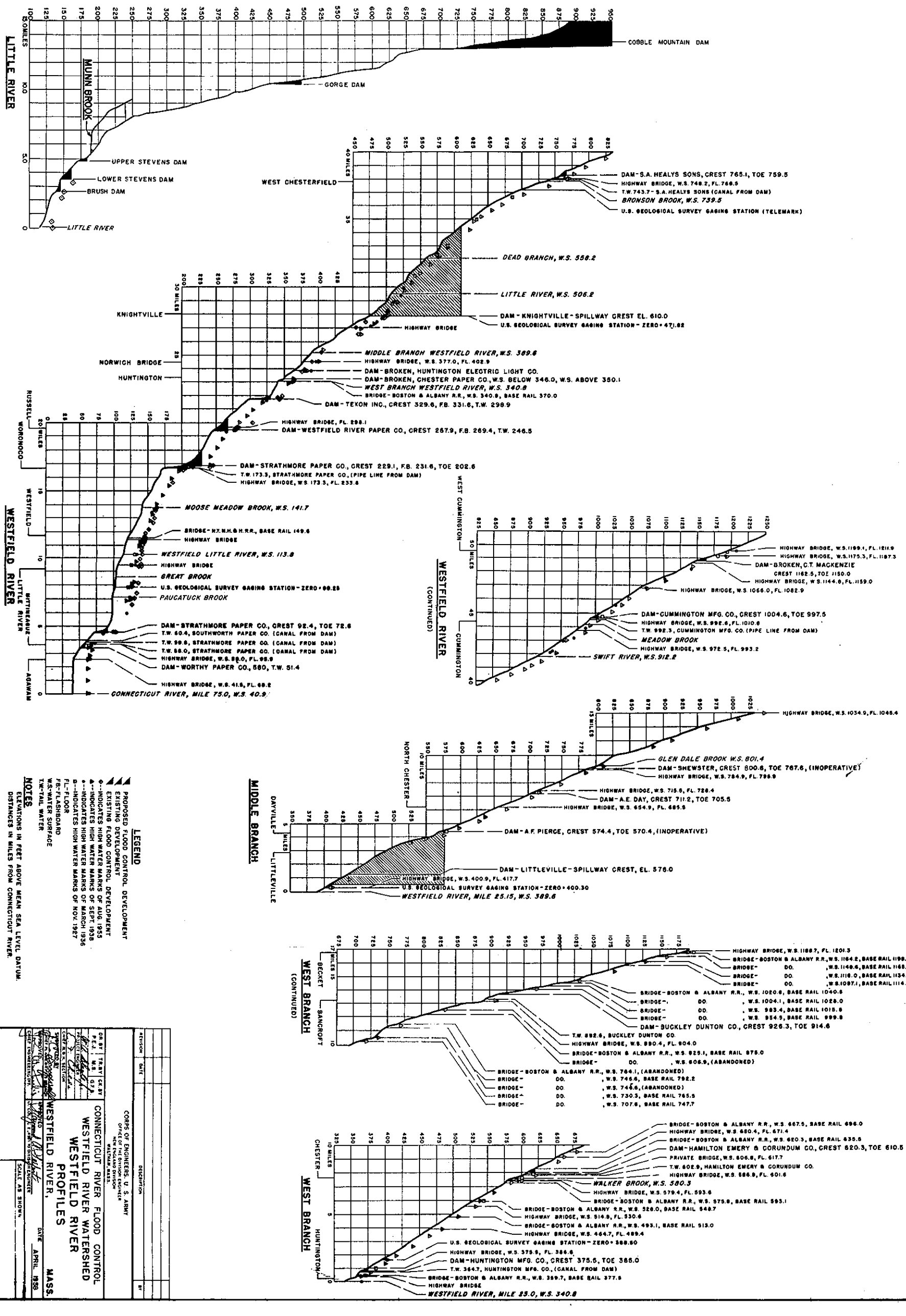
* Maintained By State Of Connecticut, Department of Environmental Protection, Water and Related Resources Unit.

ORGANIZATION CHART

RESERVOIR REGULATION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
SEPTEMBER 1977

PLATE H-20



LEGEND

PROPOSED FLOOD CONTROL DEVELOPMENT
EXISTING DEVELOPMENT
EXISTING FLOOD CONTROL DEVELOPMENT
⊕--INDICATES HIGH WATER MARKS OF AUG. 1955
▲--INDICATES HIGH WATER MARKS OF SEPT. 1938
⊖--INDICATES HIGH WATER MARKS OF MARCH 1936
B--INDICATES HIGH WATER MARKS OF NOV. 1927
FL-FLOOR
FB-FLASHBOARD
W.S.-WATER SURFACE
T.W.-TAIL WATER

NOTES

ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL DATUM.
DISTANCES IN MILES FROM CONNECTICUT RIVER.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
WALTHAM, MASS.

DR. BY P.C.A. | TR. BY M.B. | CK. BY G.J.A.
PROJECT ENGINEER
CHIEF, H.S.L. SECTION
SUPERVISED
CHIEF, P. & C. BRANCH
APPROVED
CHIEF ENGINEERING DIV.

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD RIVER WATERSHED
WESTFIELD RIVER,
PROFILES
MASS.

DATE APRIL 1938
SCALE AS SHOWN
SHEET 1

CORPS OF ENGINEERS
U.S. ARMY

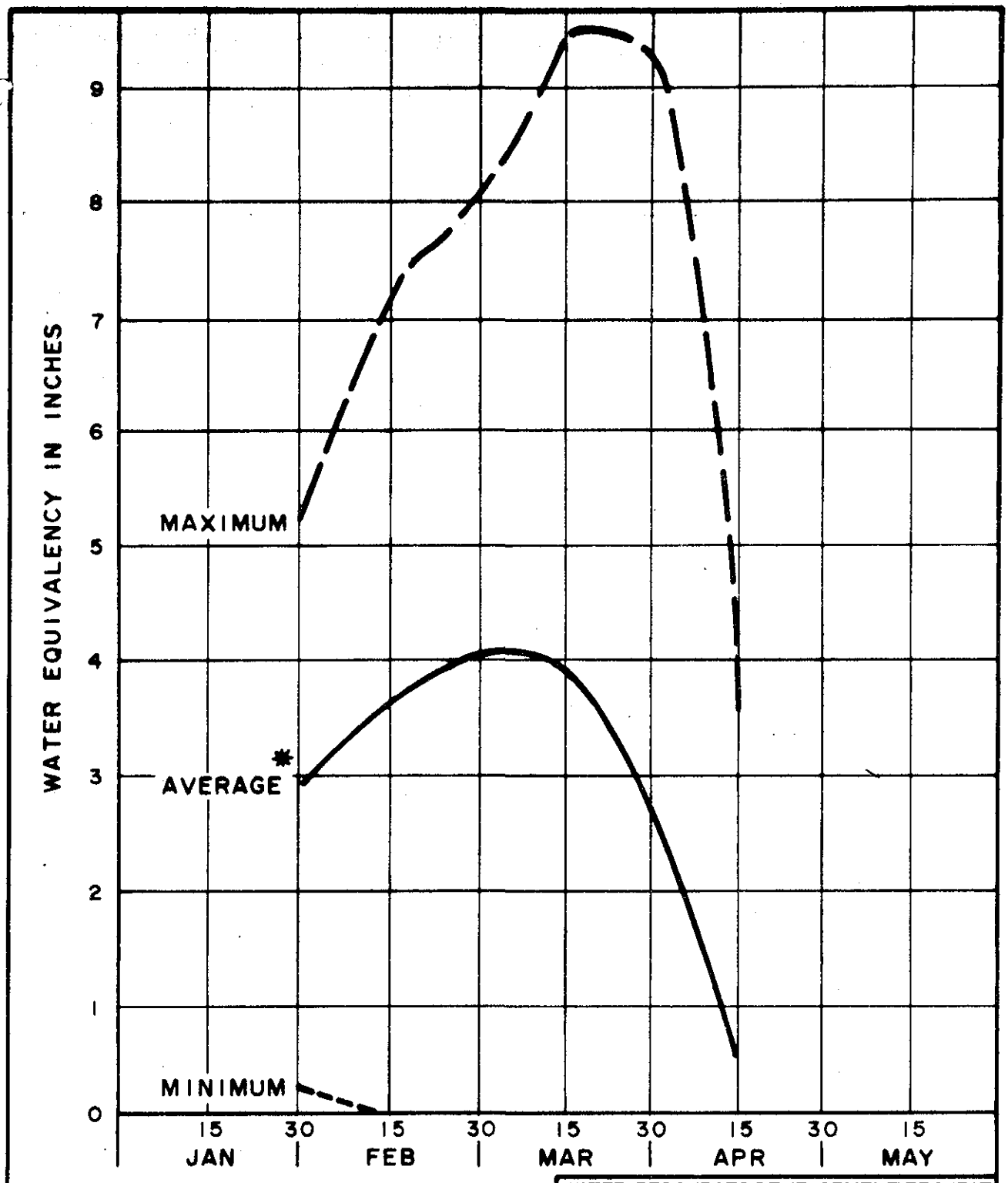
PLATE H-21

ANNUAL PRECIPITATION
WESTFIELD RIVER BASIN
(DEPTH IN INCHES)

Calendar Year	Westfield, Mass. (Elevation 210 ft. msl) 70 Years of Record 1906 - 1975	Knightville Dam, Mass. (Elevation 630 ft. msl) 27 Years of Record 1949-1975	Chester, Mass.[1] (Elevation 600 ft. msl) 42 Years of Record 1913-1956	Peru, Mass.[2] (Elevation 1,860 ft. msl) 44 Years of Record 1931-1974
1905	-	-	-	-
1906	43.6	-	-	-
1907	53.8	-	-	-
1908	40.6	-	-	-
1909	45.3	-	-	-
1910	38.9	-	-	-
1911	46.6	-	-	-
1912	46.6	-	-	-
1913	46.1	-	40.3	-
1914	41.8	-	32.2	-
1915	51.0	-	46.8	-
1916	41.1	-	40.7	-
1917	49.4	-	35.7	-
1918	40.2	-	38.8	-
1919	48.9	-	47.1	-
1920	66.3	-	48.4	-
1921	42.5	-	35.2	-
1922	47.0	-	45.4	-
1923	48.0	-	42.5	-
1924	41.3	-	39.4	-
1925	48.0	-	43.5	-
1926	45.5	-	43.9	-
1927	59.8	-	60.4	-
1928	48.7	-	45.1	-
1929	-	-	48.1	-
1930	37.4	-	36.3	-
1931	43.6	-	44.0	41.0
1932	47.3	-	45.7	41.8
1933	46.1	-	51.0	52.4
1934	56.5	-	-	50.4
1935	33.7	-	35.4	-
1936	52.6	-	51.1	51.4
1937	57.9	-	-	60.3
1938	64.3	-	58.5	57.2
1939	-	-	41.0	-
1940	42.6	-	43.4	46.1
1941	-	-	40.1	36.1
1942	51.5	-	53.5	54.2
1943	39.1	-	46.9	-
1944	39.6	-	42.2	-
1945	52.2	-	58.7	65.3
1946	38.3	-	38.5	43.2
1947	43.6	-	45.8	46.8
1948	41.9	-	49.7	54.2
1949	36.2	32.2	37.9	46.3
1950	42.2	-	46.9	-
1951	52.5	49.5	51.1	-
1952	49.5	47.7	54.6	50.6
1953	49.2	52.2	53.4	53.2
1954	48.9	51.7	57.1	55.0
1955	70.3[3]	62.2[3]	67.5[3]	65.4[3]
1956	42.3	38.8	44.7	57.7
1957	33.4	32.7	-	36.6
1958	47.0	43.4	-	44.0
1959	48.6	47.5	-	52.9
1960	50.0	43.4	-	48.9
1961	40.4	40.0	-	41.0
1962	36.6	35.7	-	40.9
1963	35.6	34.4	38.7	37.5
1964	30.1	29.7[4]	39.4	37.2
1965	29.7[4]	31.4	33.9[4]	34.7[4]
1966	38.1	35.8	48.6	38.7
1967	40.1	42.9	56.1	-
1968	47.0	46.6	61.9	50.6
1969	47.7	50.6	67.8	-
1970	38.3	41.2	52.9	-
1971	37.7	42.1	61.6	-
1972	55.2	54.9	75.2	-
1973	51.6	53.1	67.2	-
1974	46.0	47.2	56.7	-
1975	61.2	59.0	76.2	-
MEAN	45.2	43.6	48.4	48.2

(1) discontinued in 1957. New station located in vicinity of the original station since 1962.
(2) discontinued in 1969.
(3) Maximum Annual Precipitation
(4) Minimum Annual Precipitation

PLATE H-22



* PERIOD OF RECORD: 1950 - 1977

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN

WESTFIELD RIVER

WATER EQUIVALENT OF SNOW COVER

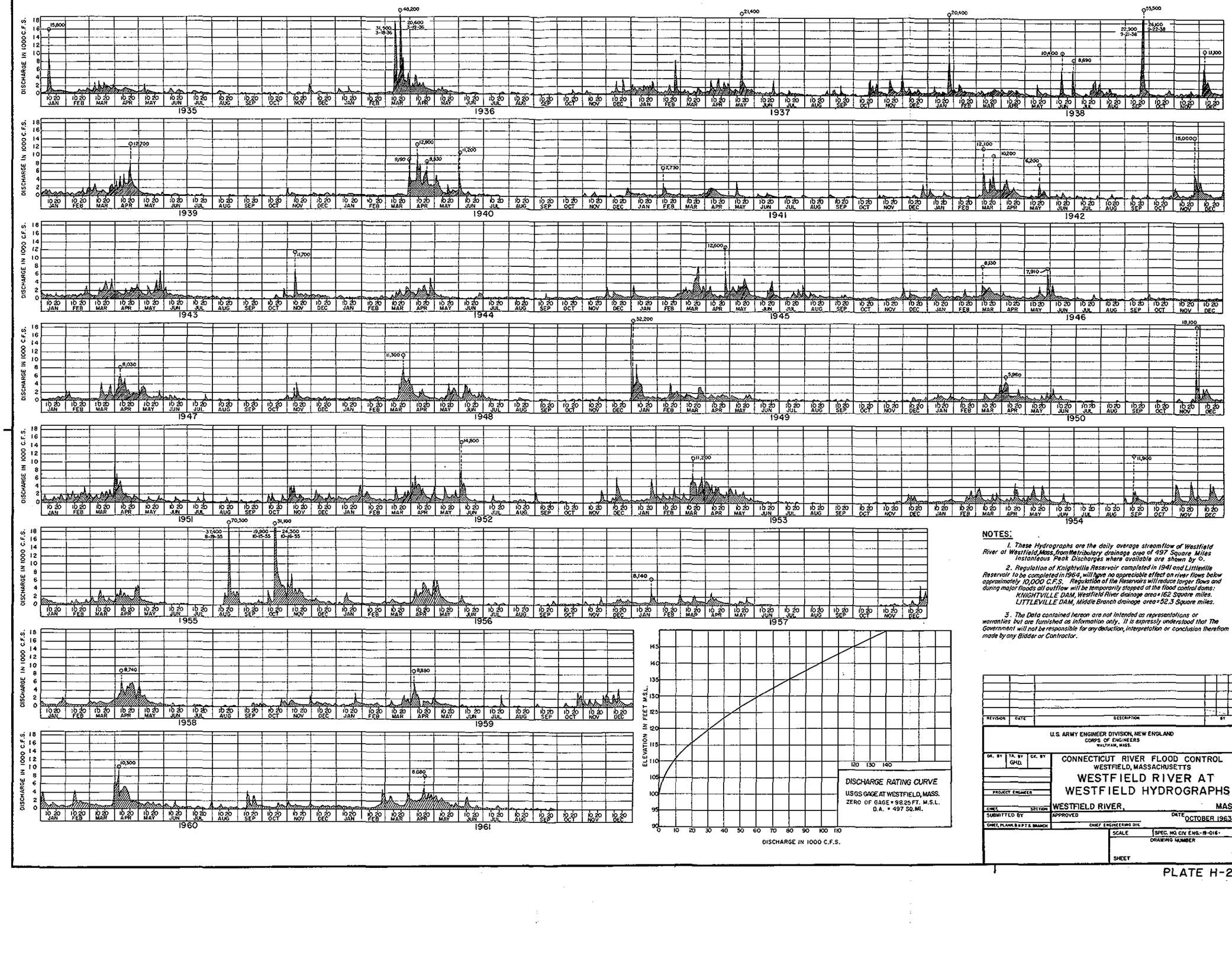
NEW ENGLAND DIVISION, WALTHAM, MASS.

JUNE 1977

PLATE H-23

CORPS OF ENGINEERS

U. S. ARMY



NOTES:

1. These Hydrographs are the daily average streamflow of Westfield River at Westfield, Mass. from the tributary drainage area of 497 Square Miles Instantaneous Peak Discharges where available are shown by ○.

2. Regulation of Knightville Reservoir completed in 1941 and Littleville Reservoir to be completed in 1964, will have no appreciable effect on river flows below approximately 10,000 C.F.S. Regulation of the Reservoirs will reduce larger flows and during major floods all outflow will be temporarily stopped at the flood control dams:
KNIGHTVILLE DAM, Westfield River drainage area = 162 Square miles.
LITTLEVILLE DAM, Middle Branch drainage area = 52.3 Square miles.

3. The Data contained hereon are not intended as representations or warranties but are furnished as information only. It is expressly understood that The Government will not be responsible for any deduction, interpretation or conclusion therefrom made by any Bidder or Contractor.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
	G.M.D.	

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANS & RPTS. BRANCH

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD, MASSACHUSETTS

WESTFIELD RIVER AT WESTFIELD HYDROGRAPHS

WESTFIELD RIVER, MASS.

APPROVED

DATE OCTOBER 1963

CHIEF ENGINEERING DIV.

SCALE

SPEC. NO. CIV ENG.-19-016-

DRAWING NUMBER

SHEET

PLATE H-24

ANNUAL RUNOFF
WESTFIELD RIVER WATERSHED

Water Year	Westfield River at Knightville, Mass. D.A. = 162 Sq. Mi. 1909-1974		Middle Branch Westfield R. at Goss Heights D.A. = 56.2 Sq. Mi. 1910-1974		West Branch Westfield R. at Huntington D.A. = 93.7 Sq. Mi. 1935-1974		Westfield River at Westfield D.A. = 497 Sq. Mi. 1915-1974	
	(cfs)	(Inches)	(cfs)	(Inches)	(cfs)	(Inches)	(cfs)	(Inches)
1909	-	-	-	-	-	-	-	-
1910	308	25.8	-	-	-	-	-	-
1911	174	14.5	72	18.5	-	-	-	-
1912	385	32.4	148	38.4	-	-	-	-
1913	310	25.9	98	25.4	-	-	-	-
1914	364	30.5	126	32.6	-	-	-	-
1915	256	21.5	76	19.6	-	-	687	19.2
1916	376	31.6	120	31.2	-	-	982	27.3
1917	298	25.0	88	22.6	-	-	831	23.2
1918	248	20.8	78	20.0	-	-	738	20.7
1919	298	25.0	100	25.8	-	-	804	22.5
1920	377	31.7	126	32.7	-	-	1050	29.4
1921	367	30.7	139	35.8	-	-	993	27.7
1922	367	30.7	115	29.6	-	-	909	25.4
1923	252	21.1	79	20.3	-	-	726	20.4
1924	393	33.0	115	29.7	-	-	1000	28.0
1925	286	24.0	84	21.6	-	-	717	20.2
1926	306	25.7	94	24.2	-	-	782	22.0
1927	299	25.0	85	21.9	-	-	883	24.7
1928	537(a)	45.2(a)	182(a)	47.1(a)	-	-	1590(a)	44.1(a)
1929	294	24.6	100	25.7	-	-	852	24.0
1930	212	17.8	63	16.2	-	-	597	17.0
1931	264	22.1	73	18.8	-	-	744	21.0
1932	221	18.6	72	18.5	-	-	585	17.8
1933	430	36.1	129	33.2	-	-	1120	31.5
1934	330	27.7	102	26.4	-	-	922	25.9
1935	292	24.5	100	25.9	-	-	863	24.2
1936	326	27.5	101	26.3	175	25.4	923	26.5
1937	379	31.7	124	32.0	218	31.6	1040	29.6
1938	441	37.0	148	38.1	265	38.3	1367	37.9
1939	317	26.5	100	25.8	175	25.4	954	26.4
1940	301	25.3	98	25.3	175	25.5	884	25.1
1941	177	14.8	54	14.0	99	14.4	525	14.8
1942	269	22.5	86	22.3	161	23.3	766	22.0
1943	382	32.0	127	32.7	225	32.6	1127	31.7
1944	265	22.3	86	22.2	141	20.5	740	20.9
1945	426	35.9	139	35.8	253	36.7	1204	34.0
1946	291	24.2	92	23.7	165	24.0	833	23.5
1947	293	24.5	93	24.0	162	23.4	796	22.6
1948	326	27.4	108	27.9	192	27.9	952	27.3
1949	297	24.9	91	23.5	165	24.1	871	24.5
1950	252	21.1	80	20.8	142	20.8	684	20.2
1951	348	29.2	113	29.0	196	28.7	1061	29.0
1952	454	38.1	154	39.8	255	37.0	1362	37.3
1953	407	34.1	132	34.2	224	32.5	1227	33.5
1954	303	25.4	93	24.1	170	24.6	871	23.8
1955	405	33.9	132	34.2	243	35.2	1298	35.5
1956	493	41.4	153	39.6	287(a)	41.7(a)	1532	42.0
1957	208	17.5	67	17.4	118	17.1	602	16.4
1958	327	27.4	99	25.5	173	25.1	971	26.5
1959	261	21.9	85	21.9	151	21.8	754	20.6
1960	436	36.6	139	35.9	242	35.2	1252	34.3
1961	310	26.0	100	25.7	186	26.9	972	26.6
1962	207	17.4	67	17.3	118	17.1	636	17.4
1963	234	19.6	73	18.8	127	18.4	687	18.8
1964	237	19.9	82	21.2	140(b)	20.4(b)	708(b)	19.4
1965	137(b)	11.5(b)	43(b)	11.0(b)	74	10.7(b)	406	11.1(b)
1966	203	17.0	57	14.8	96	14.0	543	14.8
1967	315	26.4	92	23.8	165	23.9	861	23.5
1968	296	24.9	101	26.1	178	25.8	906	24.8
1969	351	29.4	110	28.5	199	28.8	1036	28.3
1970	351	29.4	110	28.5	199	28.8	1026	26.0
1971	276	23.1	86	22.8	169	24.5	820	22.4
1972	460	38.7	157	40.7	296	43.1	1393	38.2
1973	477	40.0	144	37.1	277	40.1	1975	37.6
1974	378	31.6	117	30.0	219	31.7	1095	29.9
Average	321	26.9	103	26.6	185	26.8	941	25.7

(a) Maximum Annual Runoff
(b) Minimum Annual Runoff

PLATE H-25

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01_7(_00
Table No. 20
Begin 66 10 01 __ (YR. MO. D. HR.)

Rating table for Connecticut River at Montague City, Mass.
from October 1, 1966 *to* _____, *from* _____ *to* _____, *from* _____ *to* _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
17.00	30600	360	19.00	39000	380	21.00	46800	400	23.00	55000	440	25.00	64000	480	27.00	73800	520	29.00	84200	540
.10	30960	360	.10	39380	380	.10	47200	400	.10	55440	440	.10	64480	480	.10	74320	520	.10	84740	540
.20	31320	360	.20	39760	380	.20	47600	400	.20	55880	440	.20	64960	480	.20	74840	520	.20	85280	540
.30	31680	360	.30	40140	380	.30	48000	400	.30	56320	440	.30	65440	480	.30	75360	520	.30	85820	540
.40	32040	360	.40	40520	380	.40	48400	400	.40	56760	440	.40	65920	480	.40	75880	520	.40	86360	540
.50	32400	360	.50	40900	380	.50	48800	400	.50	57200	440	.50	66400	480	.50	76400	520	.50	86900	540
.60	32760	360	.60	41280	380	.60	49200	400	.60	57640	440	.60	66880	480	.60	76920	520	.60	87440	540
.70	33120	360	.70	41660	380	.70	49600	400	.70	58080	440	.70	67360	480	.70	77440	520	.70	87980	540
.80	33480	360	.80	42040	380	.80	50000	400	.80	58520	440	.80	67840	480	.80	77960	520	.80	88520	540
.90	33840	360	.90	42420	380	.90	50400	400	.90	59660	440	.90	68320	480	.90	78480	520	.90	89060	540
18.00	35200	380	20.00	42800	400	22.00	50800	420	24.00	59400	460	26.00	68800	500	28.00	79000	520	30.00	89600	540
.10	35580	380	.10	43200	400	.10	51220	420	.10	59860	460	.10	69300	500	.10	79520	520	.10	90140	540
.20	35960	380	.20	43600	400	.20	51640	420	.20	60320	460	.20	69800	500	.20	80040	520	.20	90680	540
.30	36340	380	.30	44000	400	.30	52060	420	.30	60780	460	.30	70300	500	.30	80560	520	.30	91220	540
.40	36720	380	.40	44400	400	.40	52480	420	.40	61240	460	.40	70800	500	.40	81080	520	.40	91760	540
.50	37100	380	.50	44800	400	.50	52900	420	.50	61700	460	.50	71300	500	.50	81600	520	.50	92300	540
.60	37480	380	.60	45200	400	.60	53320	420	.60	62160	460	.60	71800	500	.60	82120	520	.60	92840	540
.70	37860	380	.70	45600	400	.70	53740	420	.70	62620	460	.70	72300	500	.70	82640	520	.70	93380	540
.80	38240	380	.80	46000	400	.80	54160	420	.80	63080	460	.80	72800	500	.80	83160	520	.80	93920	540
.90	38620	380	.90	46400	400	.90	54580	420	.90	63540	460	.90	73300	500	.90	83680	520	.90	94460	540

This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during _____

It is identical with rating 19 above and is _____ well defined between 5,000 cfs and 150,000 cfs.

6.0 feet

Comp. by RAG date 12-8-70
Ckd. by JWB date 12-17-70

PLATE H-26

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-765

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01100

Table No. 20

Begin 351001 (YR. MO. D. HR.)

Rating table for Connecticut River at Montague City, Mass.

from October 1, 1935 *to* ____, *from* ____ *to* ____, *from* ____ *to* ____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
31.00	95000	550	33.00	106500	650	35.00	120000	700	37.00	134000	700	39.00	149000	800	41.00	165000	800	43.00	181000	800
.10	95550	550	.10	107150	650	.10	120700	700	.10	134700	700	.10	149800	800	.10	165800	800	.10	181800	800
.20	96100	550	.20	107800	650	.20	121400	700	.20	135400	700	.20	150600	800	.20	166600	800	.20	182600	800
.30	96650	550	.30	108450	650	.30	122100	700	.30	136100	700	.30	151400	800	.30	167400	800	.30	183400	800
.40	97200	550	.40	109100	650	.40	122800	700	.40	136800	700	.40	152200	800	.40	168200	800	.40	184200	800
.50	97750	550	.50	109750	650	.50	123500	700	.50	137500	700	.50	153000	800	.50	169000	800	.50	185000	800
.60	98300	550	.60	110400	650	.60	124200	700	.60	138200	700	.60	153800	800	.60	169800	800	.60	185800	800
.70	98850	550	.70	111050	650	.70	124900	700	.70	138900	700	.70	154600	800	.70	170600	800	.70	186600	800
.80	99400	550	.80	111700	650	.80	125600	700	.80	139600	700	.80	155400	800	.80	171400	800	.80	187400	800
.90	99950	550	.90	112350	650	.90	126300	700	.90	140300	700	.90	156200	800	.90	172200	800	.90	188200	800
32.00	100500	600	34.00	113000	700	36.00	127000	700	38.00	141000	800	40.00	157000	800	42.00	173000	800	44.00	189000	800
.10	101100	600	.10	113700	700	.10	127700	700	.10	141800	800	.10	157800	800	.10	173800	800	.10	189800	800
.20	101700	600	.20	114400	700	.20	128400	700	.20	142600	800	.20	158600	800	.20	174600	800	.20	190600	800
.30	102300	600	.30	115100	700	.30	129100	700	.30	143400	800	.30	159400	800	.30	175400	800	.30	191400	800
.40	102900	600	.40	11580	700	.40	129800	700	.40	144200	800	.40	160200	800	.40	176200	800	.40	192200	800
.50	103500	600	.50	116500	700	.50	130500	700	.50	145000	800	.50	161000	800	.50	177000	800	.50	193000	800
.60	104100	600	.60	117200	700	.60	131200	700	.60	145800	800	.60	161800	800	.60	177800	800	.60	193800	800
.70	104700	600	.70	117900	700	.70	131900	700	.70	146600	800	.70	162600	800	.70	178600	800	.70	194600	800
.80	105300	600	.80	118600	700	.80	132600	700	.80	147400	800	.80	163400	800	.80	179400	800	.80	195400	800
.90	105900	600	.90	119300	700	.90	133300	700	.90	148200	800	.90	164200	800	.90	180200	800	.90	196200	800

This table is applicable for open-channel conditions. It is based on ____ discharge measurements made during ____

It is identical with rating 19 above and is ____ well defined between 5,000 cfs and 150,000 cfs.

6.0 feet.

Comp. by RAG date 12-8-70

Ckd. by JWB date 12-17-70

PLATE H-27

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-765

CONNECTICUT RIVER
RATING TABLES

Stage (ft)	Holyoke, Mass.[1] (DA = 8,177 sq. mi.) Zero Datum 97.47 ft msl	Springfield, Mass.[2] (DA = 9,587 sq. mi.) Zero Datum 37.76 ft msl	Hartford, Conn.[3] (DA = 10,428 sq. mi.) Zero Datum 0.55 ft msl
0	0	0	0
1	4,000	1,500	2,000
2	9,000	3,000	4,000
3	16,000	6,000	6,500
4	24,000	11,000	9,500
5	35,000	16,000	12,500
6	46,000	22,000	15,800
7	60,000	28,000	19,600
8	74,000	35,000	23,400
9	90,000	42,000	27,600
10	105,000	50,000	32,000
11	124,000	58,000	37,000
12	143,000	66,000	42,000
13	162,000	74,000	47,000
14	182,000	82,000	53,000
15	203,000	94,000	59,500
16	226,000	104,000	66,000
17		114,000	72,500
18		126,000	80,000
19		138,000	87,500
20		151,000	95,000
21		166,000	104,000
22		180,000	113,500
23		194,000	123,500
24		210,000	133,500
25		225,000	143,500
26		240,000	153,500
27		257,000	163,500
28		274,000	173,700
29			184,000
30			194,500
31			205,000
32			215,500
33			226,000
34			237,000

(1) gage located at Holyoke Water Power Company Dam.
(2) gage located at York Street Pumping Station.
(3) gage located at Buckley Bridge.

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01183998
Table No. 29
Begin 671001 (YR. MO. D. HR.)

Rating table for Connecticut River at Thompsonville, Conn.

from Oct. 1970 *to* ____, *from* ____ *to* ____, *from* ____ *to* ____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
0.00			2.00	12800	1100	4.00	43000	1800	6.00	80000	1900	8.00	118000	1900	10.00	156000	1900	12.00	194000	1900
.10			.10	13900	1100	.10	44800		.10	81900		.10	119900		.10	157900		.10	195900	
.20			.20	15000	1100	.20	46600		.20	83800		.20	121800		.20	159800		.20	197800	
.30			.30	16100	1200	.30	48400		.30	85700		.30	123700		.30	161700		.30	199700	
.40			.40	17300	1200	.40	50200		.40	87600		.40	125600		.40	163600		.40	201600	
.50			.50	18500	1300	.50	52000		.50	89500		.50	127500		.50	165500		.50	203500	
.60			.60	19800	1300	.60	53800		.60	91400		.60	129400		.60	167400		.60	205400	
.70			.70	21100	1400	.70	55600		.70	93300		.70	131300		.70	169300		.70	207300	
.80			.80	22500	1400	.80	57400		.80	95200		.80	133200		.80	171200		.80	209200	
.90			.90	23900	1500	.90	59200	1800	.90	97100		.90	135100		.90	173100		.90	211100	
1.00			3.00	25400	1600	5.00	61000	1900	7.00	99000		9.00	137000		11.00	175000		13.00	213000	
.10			.10	27000	1700	.10	62900		.10	100900		.10	138900		.10	176900		.10	214900	
.20			.20	28700	1700	.20	64800		.20	102800		.20	140800		.20	178800		.20	216800	
.30	6420	780	.30	30400	1800	.30	66700		.30	104700		.30	142700		.30	180700		.30	218700	
.40	7200	850	.40	32200		.40	68600		.40	106600		.40	144600		.40	182600		.40	220600	
.50	8050	900	.50	34000		.50	70500		.50	108500		.50	146500		.50	184500		.50	222500	
.60	8950	900	.60	35800		.60	72400		.60	110400		.60	148400		.60	186400		.60	224400	
.70	9850	950	.70	37600		.70	74300		.70	112300		.70	150300		.70	188300		.70	226300	
.80	10100	1000	.80	39400		.80	76200		.80	114200		.80	152200		.80	190200		.80	228200	
.90	11800	1000	.90	41200	1800	.90	78100	1900	.90	116100	1900	.90	154100	1900	.90	192100	1900	.90	230100	1900

This table is applicable for open-channel conditions. It is based on ____ discharge measurements made during ____

____ and is ____ well defined between ____ cfs and ____ cfs.

Comp. by ____ date ____

Ckd. by ____ date ____

PLATE H-29

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—245-765

9-210
(Rev. 2-6)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. _____

Table No. _____

Begin _____ (YR. MO. D. HR.)

Rating table for Connecticut River at Thompsonville, Connecticut

from _____ *to* _____, *from* _____ *to* _____, *from* _____ *to* _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	*Cfs*	*Cfs*	*Feet*	*Cfs*	*Cfs*	*Feet*	*Cfs*	*Cfs*	*Feet*	*Cfs*	*Cfs*	*Feet*	*Cfs*	*Cfs*	*Feet*	*Cfs*	*Cfs*	*Feet*	*Cfs*	*Cfs*
14.00	232000	1900	16.00	271000	2000	.00			.00			.00			.00			.00		
.10	233900		.10	273000		.10			.10			.10			.10			.10		
.20	235800		.20	275000		.20			.20			.20			.20			.20		
.30	237700		.30	277000		.30			.30			.30			.30			.30		
.40	249600		.40	279000		.40			.40			.40			.40			.40		
.50	241500		.50	281000		.50			.50			.50			.50			.50		
.60	243400		.60	283000	2000	.60			.60			.60			.60			.60		
.70	245300		.70			.70			.70			.70			.70			.70		
.80	247200		.80			.80			.80			.80			.80			.80		
.90	249100	1900	.90			.90			.90			.90			.90			.90		
15.00	251000	2000	.00			.00			.00			.00			.00			.00		
.10	253000		.10			.10			.10			.10			.10			.10		
.20	255000		.20			.20			.20			.20			.20			.20		
.30	257000		.30			.30			.30			.30			.30			.30		
.40	259000		.40			.40			.40			.40			.40			.40		
.50	261000		.50			.50			.50			.50			.50			.50		
.60	263000		.60			.60			.60			.60			.60			.60		
.70	265000		.70			.70			.70			.70			.70			.70		
.80	267000		.80			.80			.80			.80			.80			.80		
.90	269000	2000	.90			.90			.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during _____

_____ and is _____ well defined between _____ cfs and _____ cfs.

Comp. by _____ date _____

Ckd. by _____ date _____

PLATE H-30

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—249-765

9-210
(Rev. 2-6)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01183500

Table No. 38

Begin 71 10 01 __
YR. MO. D. HR.

Rating table for Westfield River near Westfield, Mass.

from 1 Oct 1971 *to* _____, *from* _____ *to* _____, *from* _____ *to* _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
2.00			4.00	450	40	6.00	1710	90	8.00	3720	120	10.00	6440	150	12.00	9570	160	14.00	13070	190
.10			.10	490	45	.10	1800	90	.10	3840	120	.10	6590	150	.10	9730	160	.10	13260	190
.20			.20	535	45	.20	1890	90	.20	3960	120	.20	6740	150	.20	9890	160	.20	13450	190
.30			.30	580	50	.30	1980	90	.30	4080	130	.30	6890	150	.30	10050	160	.30	13640	190
.40			.40	630	50	.40	2070	90	.40	4210	130	.40	7040	150	.40	10210	160	.40	13830	190
.50			.50	680	50	.50	2160	100	.50	4340	130	.50	7190	150	.50	10370	170	.50	14020	190
.60	55	17	.60	730	60	.60	2260	100	.60	4470	130	.60	7340	150	.60	10540	170	.60	14210	190
.70	72	19	.70	790	60	.70	2360	100	.70	4600	130	.70	7490	160	.70	10710	170	.70	14400	200
.80	91	21	.80	850	60	.80	2460	100	.80	4730	130	.80	7650	160	.80	10880	170	.80	14600	200
.90	112	23	.90	910	60	.90	2560	100	.90	4860	130	.90	7810	160	.90	11050	170	.90	14800	200
3.00	135	24	5.00	970	70	7.00	2660	100	9.00	4990	140	11.00	7970	160	13.00	11220	180	15.00	15000	200
.10	159	26	.10	1040	70	.10	2760	100	.10	5130	140	.10	8130	160	.10	11400	180	.10	15200	200
.20	185	28	.20	1110	70	.20	2860	100	.20	5270	140	.20	8290	160	.20	11580	180	.20	15400	200
.30	213	29	.30	1180	70	.30	2960	100	.30	5410	140	.30	8450	160	.30	11760	180	.30	15600	200
.40	242	31	.40	1250	70	.40	3060	100	.40	5550	140	.40	8610	160	.40	11940	180	.40	15800	200
.50	273	33	.50	1320	70	.50	3160	110	.50	5690	150	.50	8770	160	.50	12120	190	.50	16000	200
.60	306	35	.60	1390	80	.60	3270	110	.60	5840	150	.60	8930	160	.60	12310	190	.60	16200	200
.70	341	36	.70	1470	80	.70	3380	110	.70	5990	150	.70	9090	160	.70	12500	190	.70	16400	200
.80	377	36	.80	1550	80	.80	3490	110	.80	6140	150	.80	9250	160	.80	12690	190	.80	16600	200
.90	413	37	.90	1630	80	.90	3600	120	.90	6290	150	.90	9410	160	.90	12880	190	.90	16800	200

This table is applicable for open-channel conditions. It is based on 7 discharge measurements made during 1971 (483), 1972 (487-492),

is identical with rating 37 above 4.1 ft. and is _____ well defined between 150 cfs and _____ cfs.

Comp. by _____ date _____

Ckd. by _____ date _____

PLATE H-31

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—249-1

9-210
(Rev. 2-

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 0 1 1 3 5 0 0

Table No. 3 8

Rating table for Westfield River near Westfield, Mass.

Begin 7 1 1 0 0 1 _ _
YR. MO. D. HR.

from _____ *to* _____, *from* _____ *to* _____, *from* _____ *to* _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
16.00	17000	200	18.00	21600	240	20.00	26500	250	.00			.00			.00			.00		
.10	17220		.10	21840		.10	26750		.10			.10			.10			.10		
.20	17440		.20	22080		.20	27000		.20			.20			.20			.20		
.30	17660		.30	22320		.30	27250		.30			.30			.30			.30		
.40	17880		.40	22560		.40	27500		.40			.40			.40			.40		
.50	18100		.50	22800		.50	27750		.50			.50			.50			.50		
.60	18320		.60	23040		.60	28000		.60			.60			.60			.60		
.70	18540		.70	23280		.70	28250		.70			.70			.70			.70		
.80	18760		.80	23520		.80	28500		.80			.80			.80			.80		
.90	18980	220	.90	23760	240	.90	28750	250	.90			.90			.90			.90		
17.00	19200	240	19.00	24000	250	21.00	29000	260	.00			.00			.00			.00		
.10	19440		.10	24250		.10	29260		.10			.10			.10			.10		
.20	19680		.20	24500		.20	29520		.20			.20			.20			.20		
.30	19920		.30	24750		.30	29780		.30			.30			.30			.30		
.40	20160		.40	25000		.40	30040		.40			.40			.40			.40		
.50	20400		.50	25250		.50	30300		.50			.50			.50			.50		
.60	20640		.60	25500		.60	30560		.60			.60			.60			.60		
.70	20880		.70	25750		.70	30820		.70			.70			.70			.70		
.80	21120		.80	26000		.80	31080		.80			.80			.80			.80		
.90	21360	240	.90	26250	250	.90	31340	260	.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during _____

_____ and is _____ well defined between _____ cfs and _____ cfs.

Comp. by _____ date _____

Ckd. by _____ date _____

PLATE H-31a

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—249-765

9-219
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 0 1 8 0 0 0
Table No. 3 6
Begin 7 3 0 3 1 8
YR. MO. D. HR.

Rating table for West Branch Westfield River at Huntington, Mass.

from 18 Mar 1973 *to* ..... , *from* ..... *to* ..... , *from* ..... *to* .....

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
0.00			2.00	228	38	4.00	1840	100	6.00	4110	140	8.00	7340	180	10.00	11400	220	12.00	16200	280
.10			.10	266	42	.10	1940	100	.10	4250	140	.10	7520	180	.10	11620	220	.10	16480	280
.20			.20	308	46	.20	2040	100	.20	4390	150	.20	7700	180	.20	11840	220	.20	16760	280
.30			.30	354	51	.30	2140	100	.30	4540	150	.30	7880	180	.30	12060	220	.30	17040	280
.40			.40	405	60	.40	2240	100	.40	4690	150	.40	8060	180	.40	12280	220	.40	17320	280
.50			.50	465	70	.50	2340	100	.50	4840	160	.50	8240	200	.50	12500	240	.50	17600	280
.60			.60	535	70	.60	2440	110	.60	5000	160	.60	8440	200	.60	12740	240	.60	17880	280
.70	15	6	.70	605	75	.70	2550	110	.70	5160	160	.70	8640	200	.70	12980	240	.70	18160	280
.80	21	7	.80	680	80	.80	2660	110	.80	5320	160	.80	8840	200	.80	13220	240	.80	18440	280
.90	28	8.5	.90	760	90	.90	2770	110	.90	5480	160	.90	9040	200	.90	13460	240	.90	18720	280
1.00	36.5	10	3.00	850	90	5.00	2880	110	7.00	5640	160	9.00	9240	200	11.00	13700	240	13.00	19000	300
.10	46.5	11.5	.10	940	100	.10	2990	110	.10	5800	160	.10	9440	200	.10	13940	240	.10	19300	300
.20	58	13	.20	1040	100	.20	3100	120	.20	5960	160	.20	9640	220	.20	14180	240	.20	19600	300
.30	71	15	.30	1140	100	.30	3220	120	.30	6120	160	.30	9860	220	.30	14420	240	.30	19900	300
.40	86	17	.40	1240	100	.40	3340	120	.40	6280	160	.40	10080	220	.40	14660	240	.40	20200	300
.50	103	19	.50	1340	100	.50	3460	120	.50	6440	180	.50	10300	220	.50	14900	260	.50	20500	300
.60	122	21	.60	1440	100	.60	3580	130	.60	6620	180	.60	10520	220	.60	15160	260	.60	20800	300
.70	143	24	.70	1540	100	.70	3710	130	.70	6800	180	.70	10740	220	.70	15420	260	.70	21100	300
.80	167	28	.80	1640	100	.80	3840	130	.80	6980	180	.80	10960	220	.80	15680	260	.80	21400	300
.90	195	33	.90	1740	100	.90	3970	140	.90	7160	180	.90	11180	220	.90	15940	260	.90	21700	300

This table is applicable for open-channel conditions. It is based on 8 discharge measurements made during 1973 (437-441), 1974 (442-444), is identical with rating 35 and is ..... well defined between ..... cfs and ..... cfs.

above 2.5 ft.

Comp. by ..... date .....

Ckd. by ..... date .....

PLATE H-32

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01180500
Table No. 58
Begin 76 09 15 (YR. MO. D. HR.)

Rating table for Middle Branch Westfield River at Goss Heights

from ____ *to* ____, *from* ____ *to* ____, *from* ____ *to* ____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			2.00	68		4.00	611		.00			.00			.00			.00		
.10			.10	81		.10	653		.10			.10			.10			.10		
.20			.20	96		.20	697		.20			.20			.20			.20		
.30			.30	112		.30	743		.30			.30			.30			.30		
.40			.40	130		.40	790		.40			.40			.40			.40		
.50			.50	149		.50	838		.50			.50			.50			.50		
.60			.60	171		.60	889		.60			.60			.60			.60		
.70			.70	192		.70	940		.70			.70			.70			.70		
.80			.80	216		.80	994		.80			.80			.80			.80		
.90	.900		.90	240		.90	1049		.90			.90			.90			.90		
1.00	2.22		3.00	267		5.00	1106		.00			.00			.00			.00		
.10	4.20		.10	294		.10	1165		.10			.10			.10			.10		
.20	6.90		.20	323		.20	1225		.20			.20			.20			.20		
.30	10.6		.30	354		.30	1287		.30			.30			.30			.30		
.40	15.3		.40	387		.40	1350		.40			.40			.40			.40		
.50	21.3		.50	421		.50			.50			.50			.50			.50		
.60	28.5		.60	456		.60			.60			.60			.60			.60		
.70	36.6		.70	494		.70			.70			.70			.70			.70		
.80	45.9		.80	531		.80			.80			.80			.80			.80		
.90	56.5		.90	570		.90			.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on ____ discharge measurements made during ____ and is ____ well defined between ____ cfs and ____ cfs.

Comp. by RAG date 4/15/
Ckd. by KWT date 4/21/

PLATE H-33

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—249-769

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 01179500
Table No. 24

Rating table for Westfield River at Knightville, Massachusetts

Begin 69 10 01 __ __ (YR. MO. D. HR.)

from 1 Oct. 1969 *to* ____, *from* ____ *to* ____, *from* ____ *to* ____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
1.00			3.00	231	36	5.00	1810	130	7.00	5470	250	.00			.00			.00		
.10			.10	267	39	.10	1940	140	.10	5720	260	.10			.10			.10		
.20	0		.20	306	42	.20	2080	140	.20	5980	270	.20			.20			.20		
.30	0.1		.30	348	46	.30	2220	140	.30	6250	270	.30			.30			.30		
.40	.4		.40	394	49	.40	2360	150	.40	6520	280	.40			.40			.40		
.50	1.2		.50	443	53	.50	2510	150	.50	6800		.50			.50			.50		
.60	2.8		.60	496	59	.60	2660	160	.60			.60			.60			.60		
.70	5.6		.70	555	65	.70	2820	160	.70			.70			.70			.70		
.80	10		.80	620	70	.80	2980	160	.80			.80			.80			.80		
.90	16.5	9.0	.90	690	75	.90	3140	170	.90			.90			.90			.90		
2.00	25.5	9.5	4.00	765	80	6.00	3310	180	8.00			.00			.00			.00		
.10	35	11.5	.10	845	85	.10	3490	190	.10			.10			.10			.10		
.20	46.5	13.5	.20	930	90	.20	3680	200	.20			.20			.20			.20		
.30	60	16	.30	1020	100	.30	3880	210	.30			.30			.30			.30		
.40	76	19	.40	1120	100	.40	4090	210	.40			.40			.40			.40		
.50	95	22	.50	1220	110	.50	4300	220	.50			.50			.50			.50		
.60	117	24	.60	1330	110	.60	4520	230	.60			.60			.60			.60		
.70	141	27	.70	1440	120	.70	4750	230	.70			.70			.70			.70		
.80	168	30	.80	1560	120	.80	4980	240	.80			.80			.80			.80		
.90	198	33	.90	1680	130	.90	5220	250	.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on 24 discharge measurements made during 1965 (182), 1966 (183, 184, 186, 187), 1967 (190-194), 1968 (196-198), 1969 (200-202) and is ____ well defined between ____ cfs and ____ cfs.

Comp. by ____ date ____

1970 (203-210)

Ckd. by ____ date ____

It is identical with rating 23 below 2.1 ft. and above 3.7 ft.

PLATE H-34

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—249-76

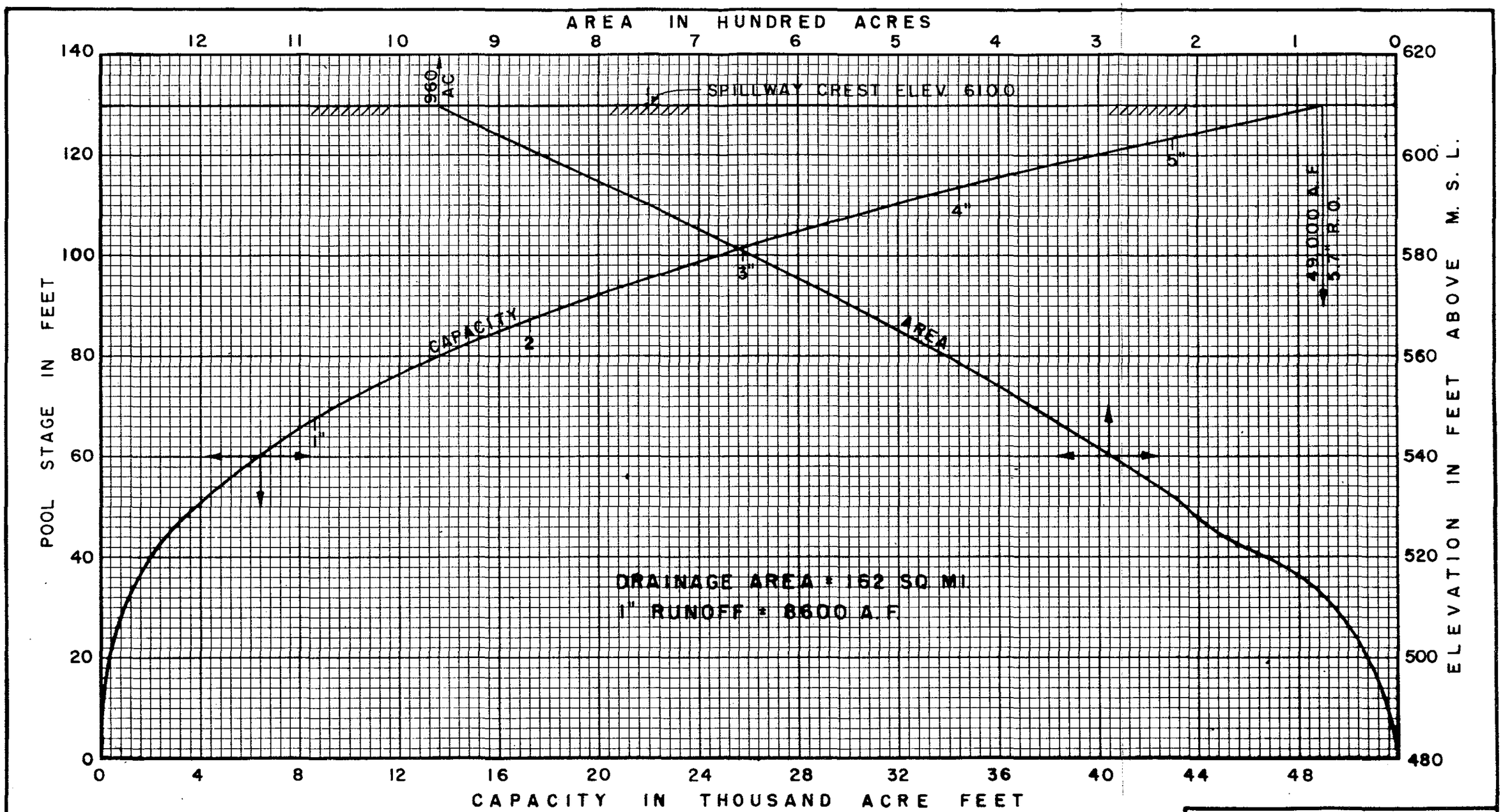
KNIGHTVILLE DAM
AREA AND CAPACITY

DRAINAGE AREA = 162 S.M.

Elev. (msl)	Stage (ft)	Area (acres)	Capacity Ac/Feet	Capacity Inches
480	0	0	0	0
490	10	12	73	.01
492	12	14	113	.01
494	14	16	153	.02
496	16	20	195	.02
498	18	25	244	.03
500	20	30	294	.03
502	22	36	384	.04
504	24	45	475	.06
506	26	55	592	.07
508	28	65	710	.08
510	30	75	872	.10
512	32	87	1035	.12
514	34	100	1235	.14
516	36	115	1435	.17
518	38	125	1705	.20
520	40	145	1975	.23
522	42	160	2317	.27
524	44	185	2660	.31
526	46	205	3045	.35
528	48	220	3430	.40
530	50	230	3857	.45
532	52	240	4285	.50
534	54	255	4802	.56
536	56	265	5320	.62
538	58	275	5892	.68
540	60	290	6466	.75
542	62	305	7072	.82
544	64	325	7680	.89
546	66	335	8350	.97
548	68	350	9020	1.04
550	70	370	9758	1.13
552	72	385	10497	1.22
554	74	400	11304	1.31
556	76	420	12113	1.40
558	78	435	12998	1.51
560	80	455	13865	1.61
562	82	470	14802	1.71
564	84	490	15740	1.82
566	86	510	16763	1.94
568	88	530	17787	2.06
570	90	545	18883	2.19
572	92	565	19980	2.31
574	94	585	21150	2.45
576	96	605	22320	2.58
578	98	625	23577	2.73
580	100	650	24836	2.88
582	102	670	26157	3.03
584	104	690	27480	3.18
586	106	715	28907	3.35
588	108	735	30335	3.51
590	110	755	31862	3.69
592	112	775	33390	3.87
594	114	795	34972	4.05
596	116	815	36555	4.23
598	118	835	38216	4.43
600	120	855	39880	4.62
602	122	875	41652	4.82
604	124	900	43425	5.03
606	126	920	45252	5.24
608	128	940	47080	5.45
610	130	960	49000	5.69

Crest Elevation = 610

PLATE H-35



WATER RESOURCES DEVELOPMENT PROJECT

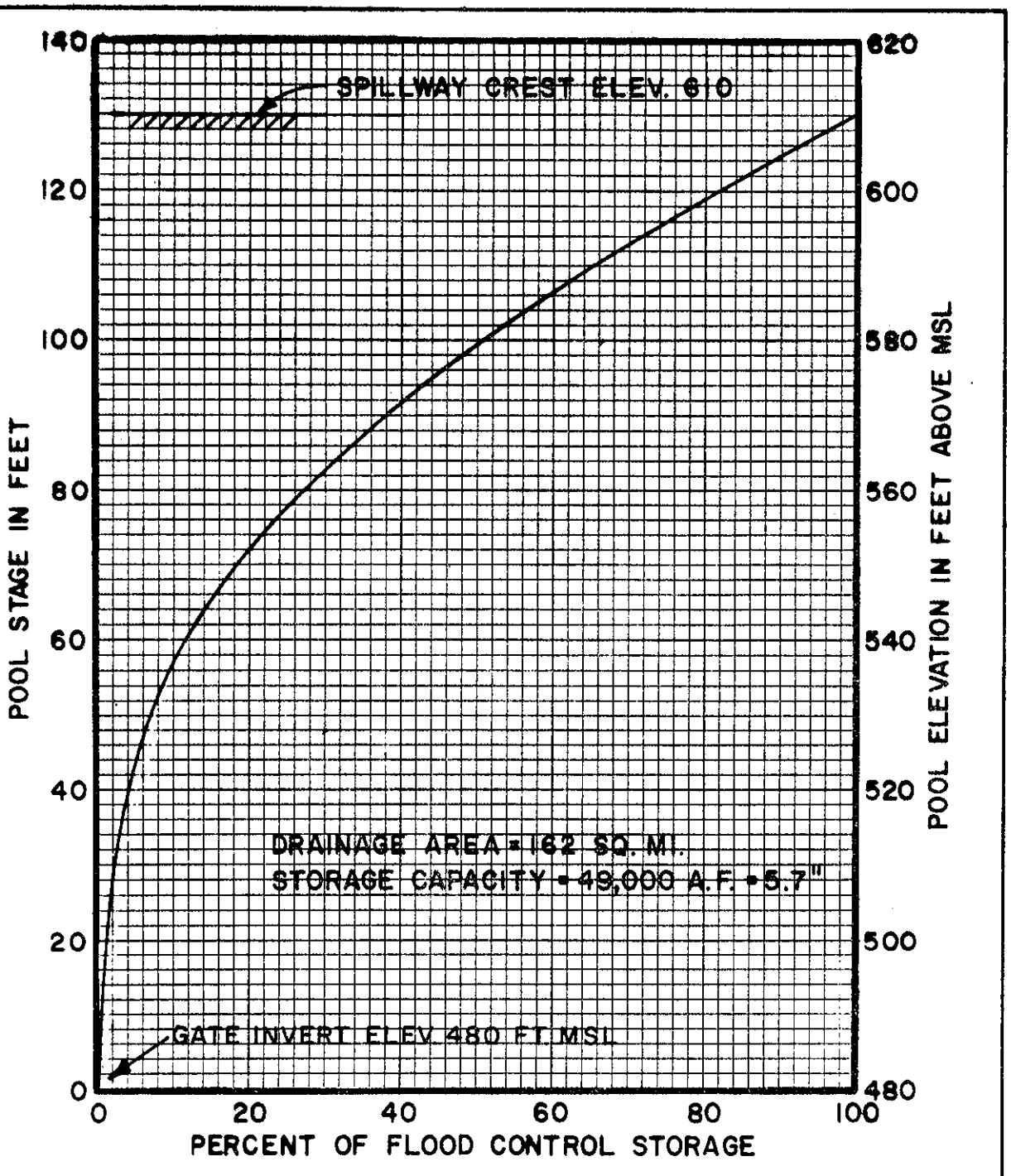
CONNECTICUT RIVER BASIN

KNIGHTVILLE DAM

AREA & CAPACITY CURVES

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-36



WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN

KNIGHTVILLE DAM

PERCENT STORAGE CURVE

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-37

LITTLEVILLE LAKE
AREA AND CAPACITY
(Drainage Area = 52.3 Square Miles)

Stage (ft)	Area (acres)	Capacity Ac/Feet	Capacity Inches	Elevation (msl)	Stage (ft)	Area (acres)	Capacity Ac/Feet	Capacity Inches
		WATER SUPPLY POOL						
0	0	0	0	480	48	120	2200	.79
3		15	.005	485	53	138	2800	1.00
8		25	.009	490	58	155	3600	1.29
13		75	.03	495	63	175	4400	1.58
18	25	150	.05	500	68	195	5300	1.90
23	38	230	.08	505	73	220	6200	2.22
28	50	400	.14	510	78	243	7300	2.62
33	67	700	.25	515	83	268	8500	2.62
38	85	1200.	.43	518	86	275	9400	3.37
43	100	1700	.61					
		FLOOD CONTROL POOL						
86	275	0	0	547	115	397	10000	3.58
87	280	314	.11	548	116	400	10400	3.73
88	283	628	.22	549	117	404	10800	3.87
89	285	943	.34	550	118	407	11200	4.02
90	290	1258	.45	551	119	411	11625	4.17
91	295	1563	.56	552	120	415	12050	4.32
92	300	1868	.67	553	121	420	12475	4.48
93	305	2174	.78	554	122	423	12900	4.63
				555	123	427	13332	4.78
94	310	2480	.89					
95	315	2797	1.00	556	124	430	13765	4.94
96	320	3115	1.12	557	125	435	14197	5.09
97	324	3432	1.23	558	126	438	14630	5.25
98	328	3750	1.34	559	127	443	15072	5.41
				560	128	446	15515	5.56
99	332	4090	1.47					
100	337	4430	1.59	561	129	450	15957	5.72
101	340	4770	1.71	562	130	454	16400	5.88
102	345	5110	1.83	563	131	457	16885	6.06
103	350	5470	1.96	564	132	461	17370	6.23
				565	133	466	17855	6.42
104	354	5830	2.09					
105	357	6190	2.22	566	134	470	18340	6.58
106	361	6550	2.35	567	135	475	18797	6.74
107	365	6922	2.48	568	136	478	19255	6.91
108	370	7295	2.62	569	137	482	19712	7.07
				570	138	485	20170	7.23
109	375	7667	2.75					
110	378	8040	2.88	571	139	490	20670	7.42
111	382	8430	3.02	572	140	495	21170	7.59
112	385	8820	3.16	573	141	498	21670	7.77
113	390	9210	3.30	574	142	502	22170	7.95
				575	143	508	22682	8.14
114	393	9600	3.44					
				576	144	510	23000	8.32

Crest Elevation = 576

PLATE H-38

AREA IN HUNDREDS OF ACRES

6 5 4 3 2 1 0

SPILLWAY CREST ELEVATION 576.0

510 AC.

275 AC.

23,000 A.F.

6,400 A.F.

FLOOD CONTROL STORAGE CAPACITY

BOTTOM OF FLOOD CONTROL STORAGE - ELEV. = 518 FT. M.S.L.

WATER SUPPLY

AREA

DRAINAGE AREA = 523.50 MI.

1" RUNOFF = 2800 A.F.

INVERT ELEVATION 432.0'

POOL ELEVATION IN FEET ABOVE M.S.L.

590 570 550 530 510 490 470 450 430

0 2 4 6 8 10 12 14 16 18 20 22 24 26

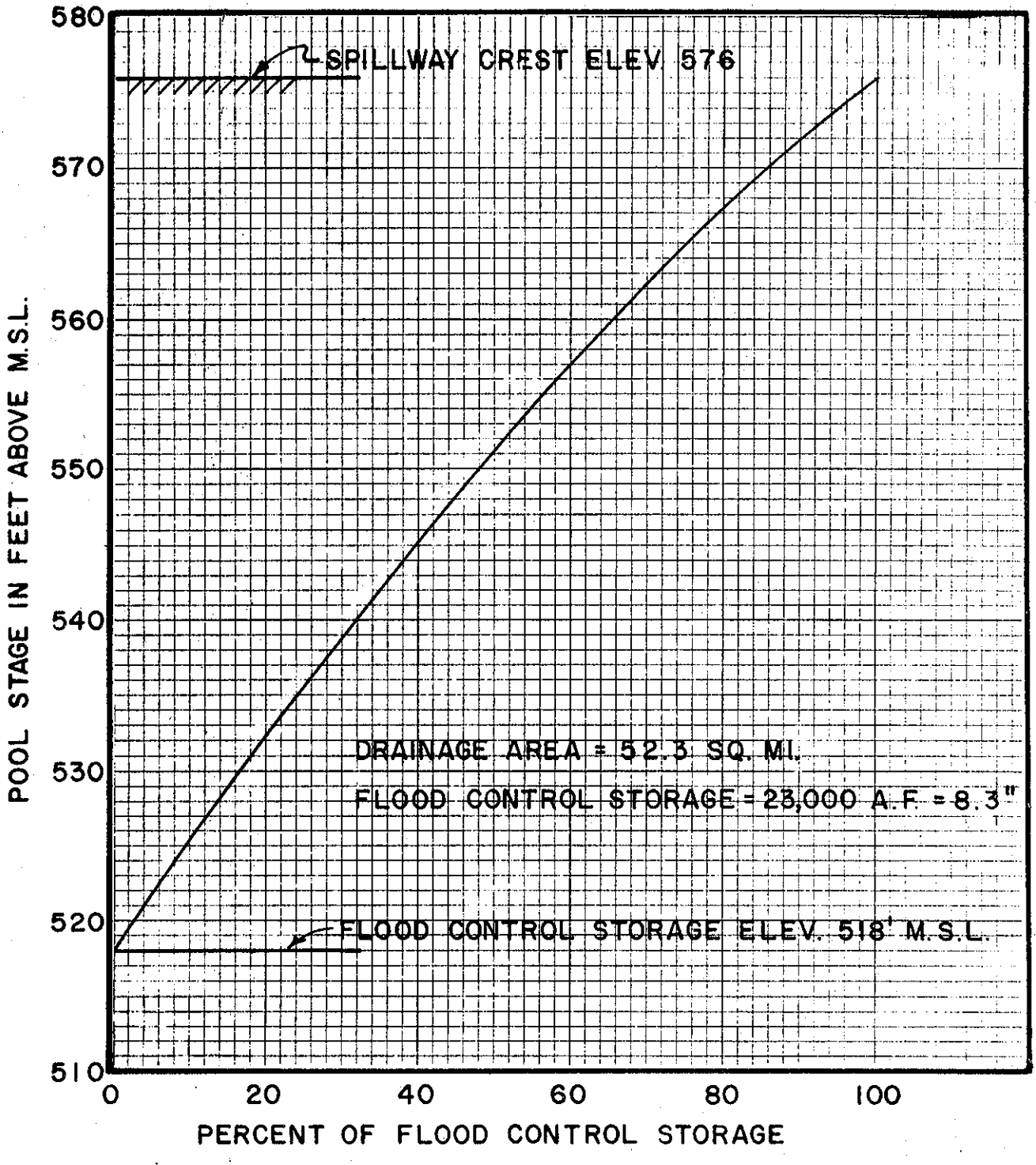
CAPACITY IN THOUSANDS OF ACRE FEET

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
LITTLEVILLE LAKE
AREA & CAPACITY CURVE

NEW ENGLAND DIVISION, WALTHAM, MA.
SEPT. 1976

PLATE H-39



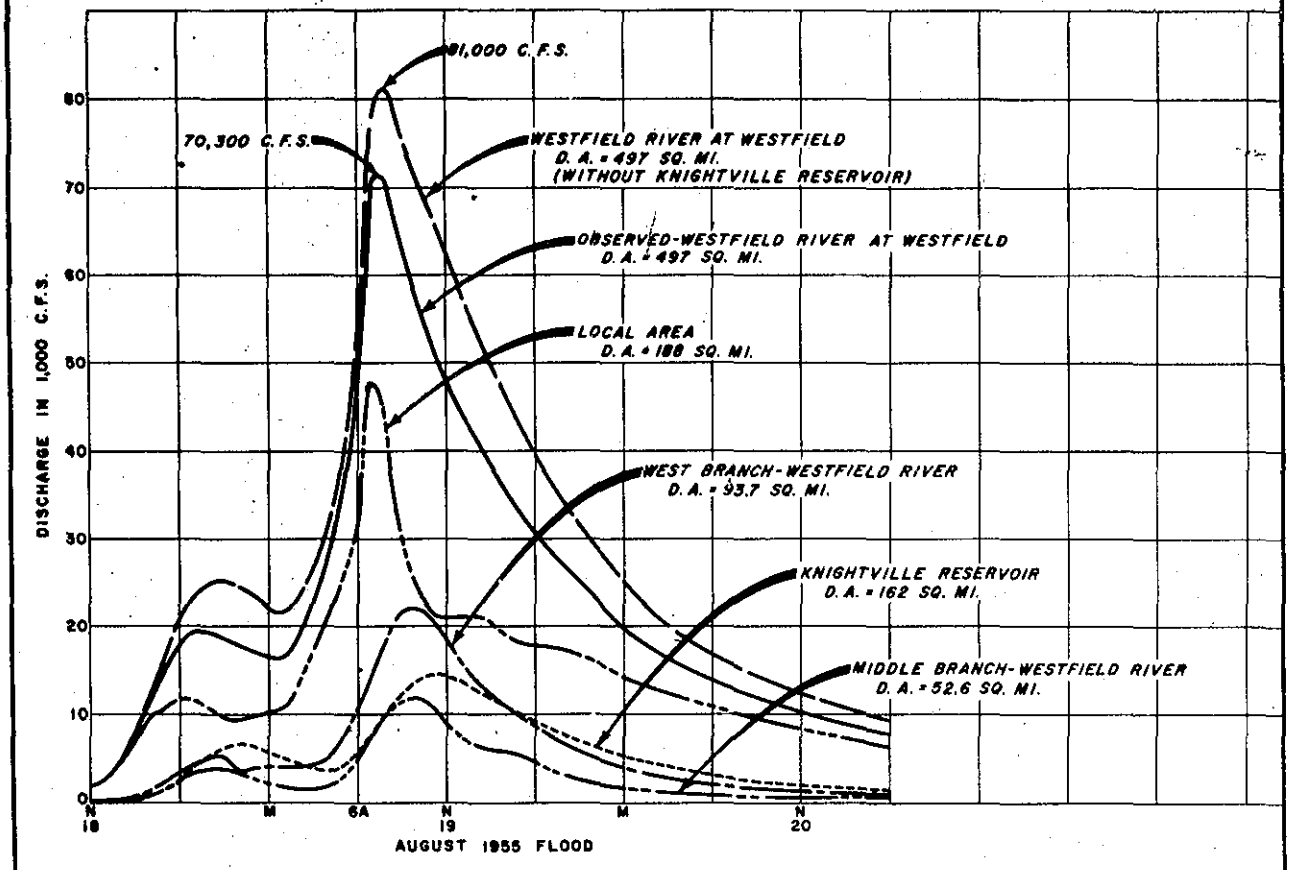
WATER RESOURCES DEVELOPMENT PROJECT

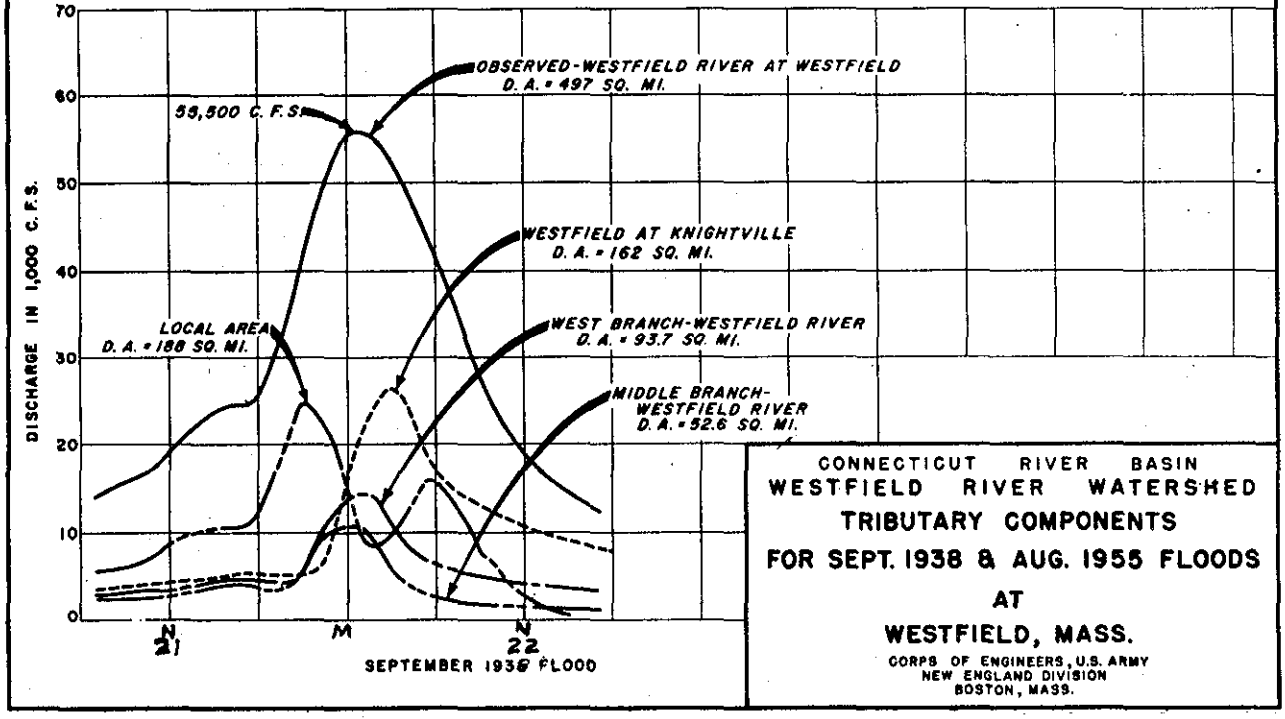
CONNECTICUT RIVER BASIN
LITTLEVILLE LAKE

PERCENT STORAGE CURVE

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-40





CONNECTICUT RIVER BASIN

WESTFIELD RIVER WATERSHED

TRIBUTARY COMPONENTS

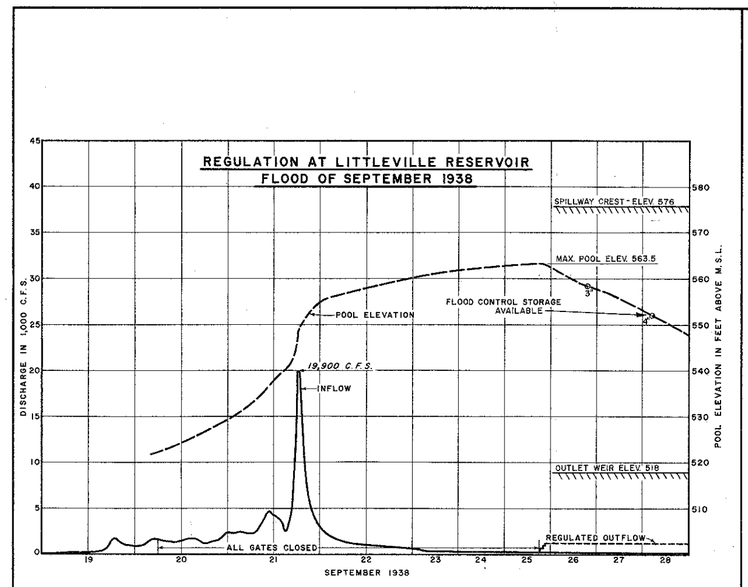
FOR SEPT. 1938 & AUG. 1955 FLOODS

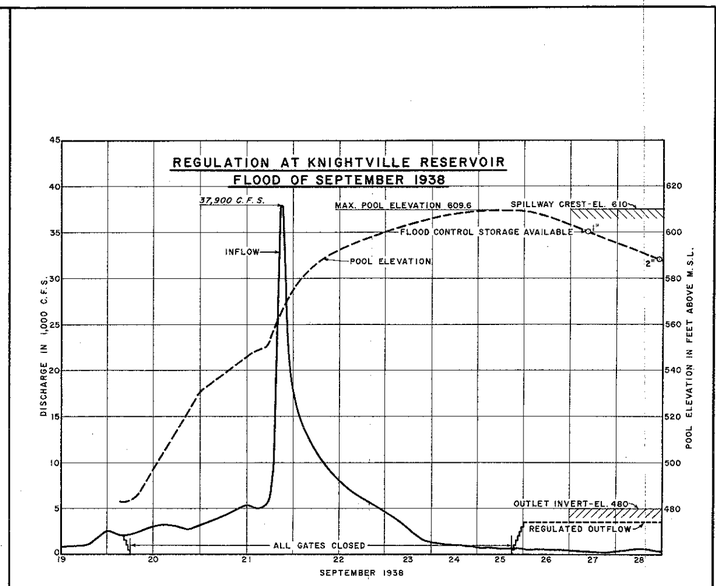
AT

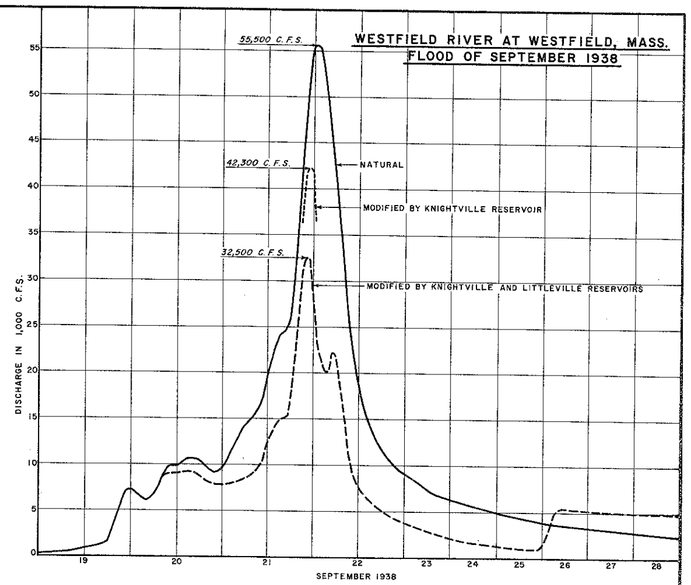
WESTFIELD, MASS.

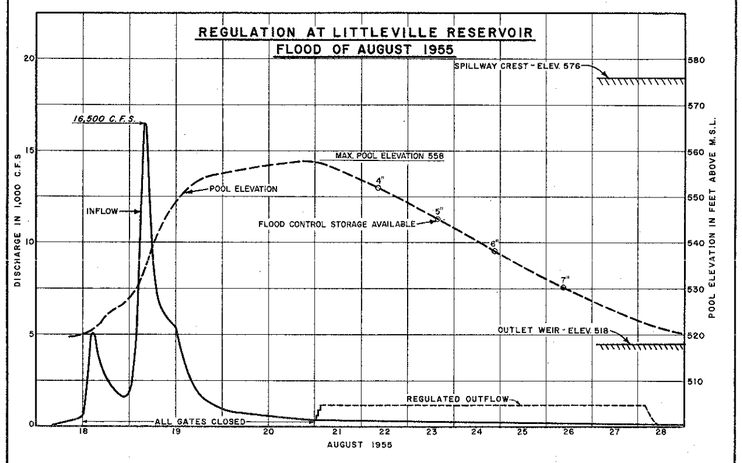
CORPS OF ENGINEERS, U.S. ARMY
NEW ENGLAND DIVISION
BOSTON, MASS.

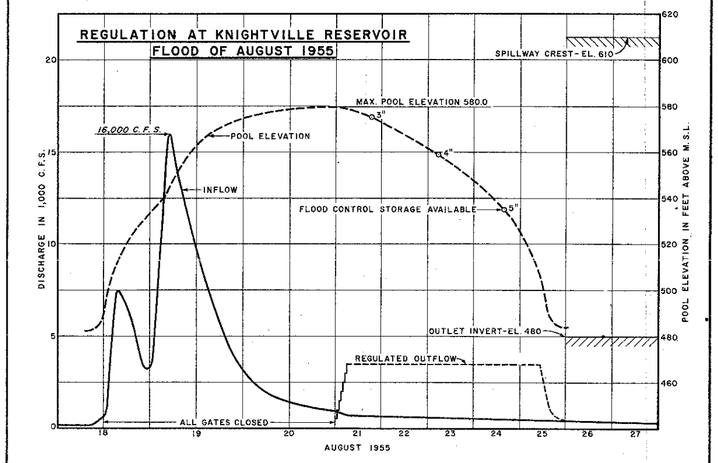
PLATE H-41

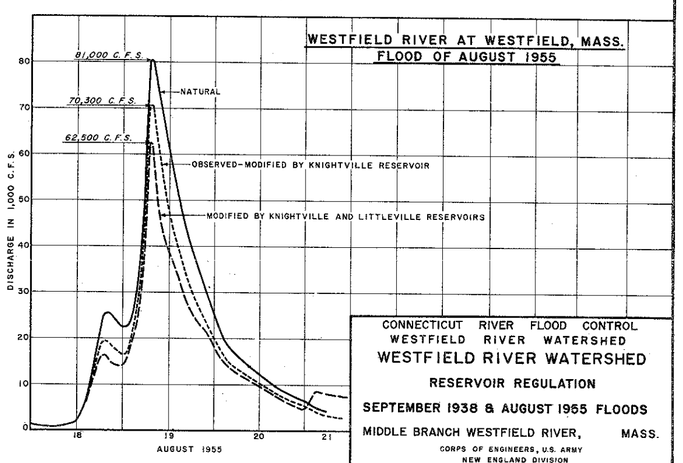












CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD RIVER WATERSHED

WESTFIELD RIVER WATERSHED

RESERVOIR REGULATION

SEPTEMBER 1938 & AUGUST 1955 FLOODS

MIDDLE BRANCH WESTFIELD RIVER, MASS.

CORPS OF ENGINEERS, U.S. ARMY
NEW ENGLAND DIVISION
WALTHAM, MASS.
APRIL 1961

PLATE H-42

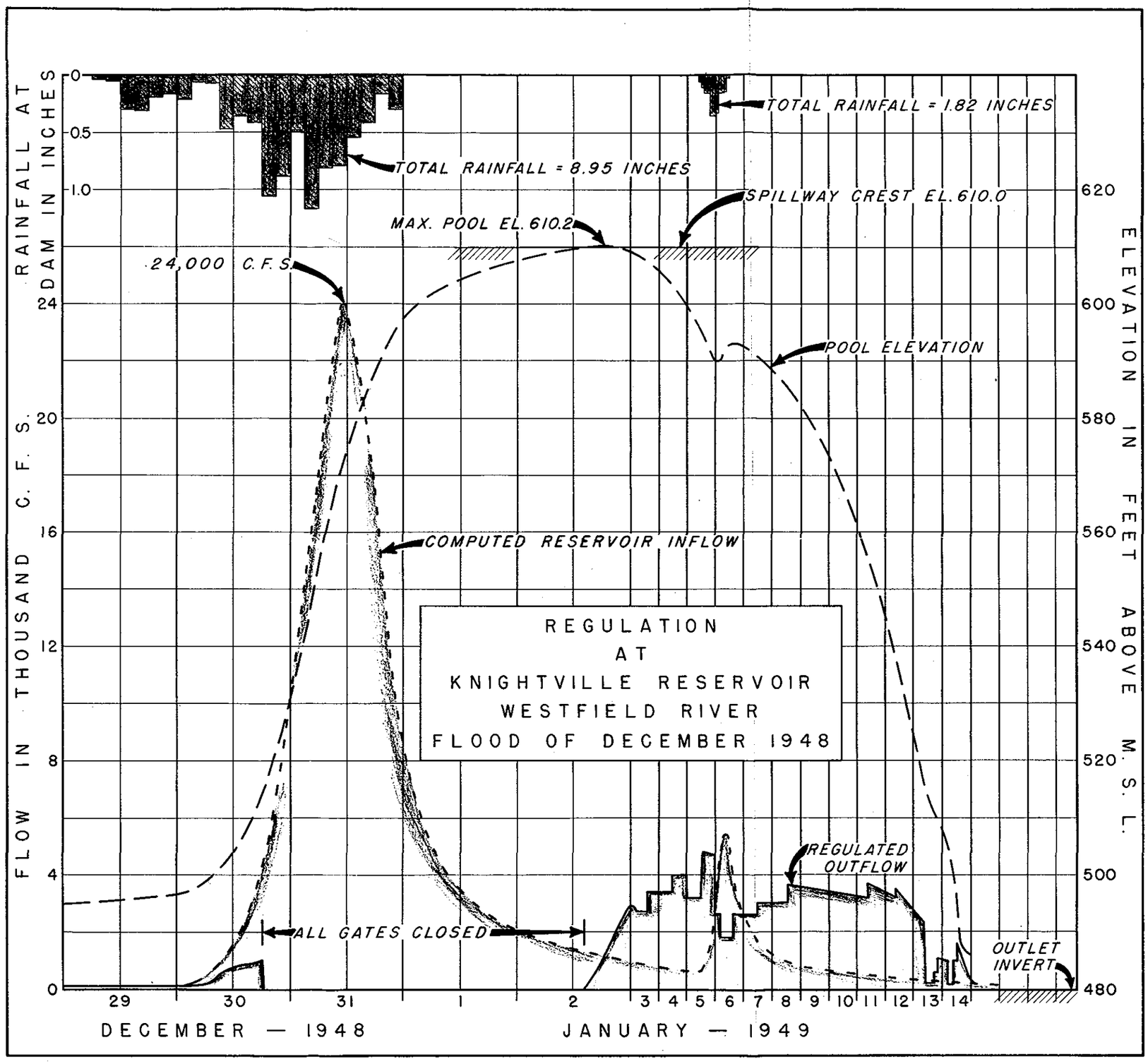
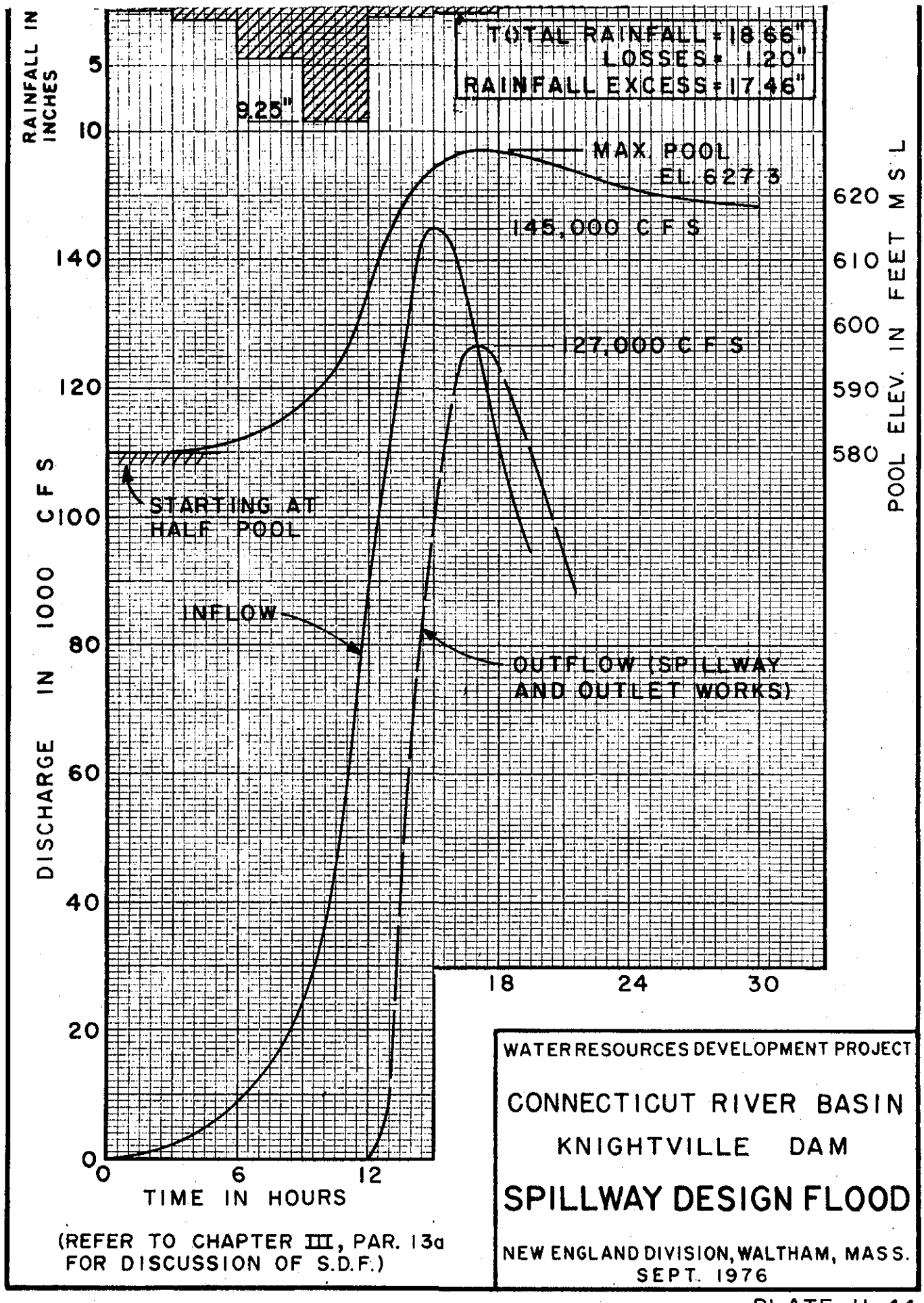

RAINFALL AT DAM IN INCHES
0
0.5
1.0
TOTAL RAINFALL = 8.95 INCHES
TOTAL RAINFALL = 1.82 INCHES
SPILLWAY CREST EL. 610.0
MAX. POOL EL. 610.2
24,000 C.F.S.
POOL ELEVATION
C. F. S.
FLOW IN THOUSAND
24
20
16
12
8
4
0
COMPUTED RESERVOIR INFLOW
REGULATION
AT
KNIGHTVILLE RESERVOIR
WESTFIELD RIVER
FLOOD OF DECEMBER 1948
REGULATED OUTFLOW
ALL GATES CLOSED
OUTLET INVERT
ELEVATION IN FEET ABOVE M. S. L.
620
600
580
560
540
520
500
480
29
30
31
1
2
3
4
5
6
7
8
9
10
11
12
13
14
DECEMBER — 1948
JANUARY — 1949

PLATE H-43



(REFER TO CHAPTER III, PAR. 13a
FOR DISCUSSION OF S.D.F.)

WATER RESOURCES DEVELOPMENT PROJECT

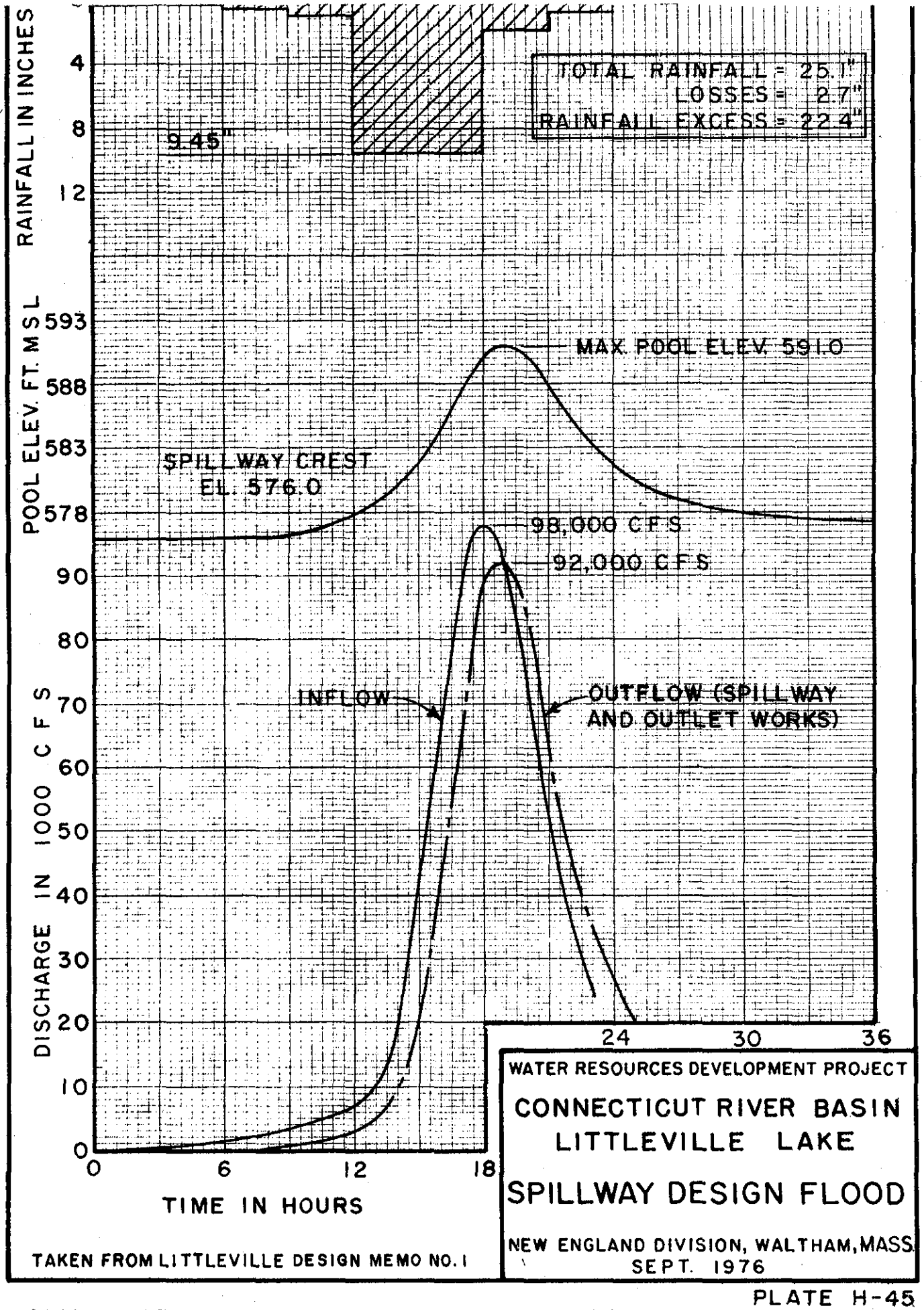
CONNECTICUT RIVER BASIN

KNIGHTVILLE DAM

SPILLWAY DESIGN FLOOD

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-44



TAKEN FROM LITTLEVILLE DESIGN MEMO NO. 1

WATER RESOURCES DEVELOPMENT PROJECT

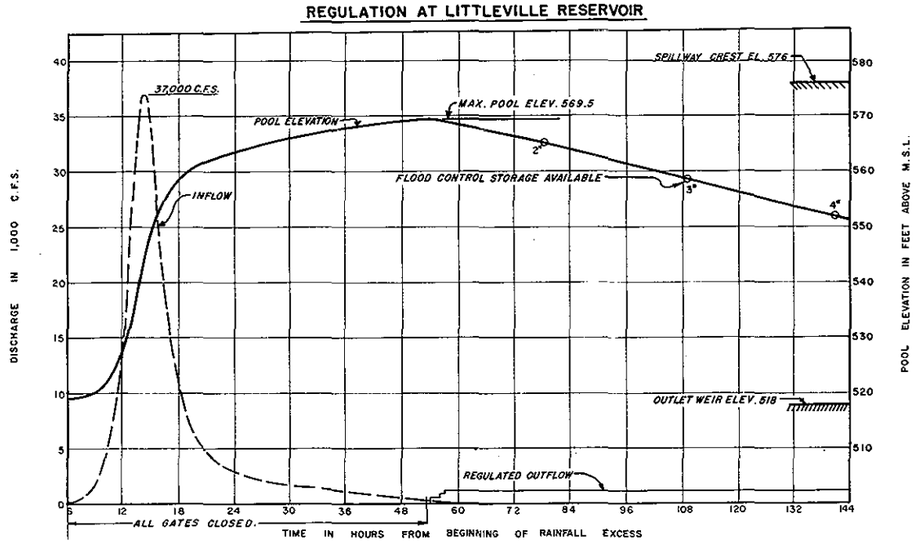
CONNECTICUT RIVER BASIN
LITTLEVILLE LAKE

SPILLWAY DESIGN FLOOD

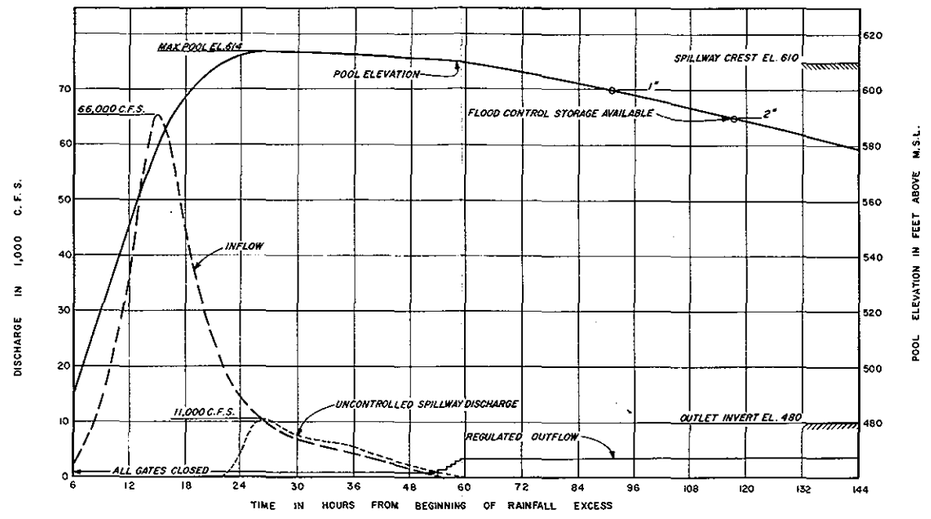
NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-45

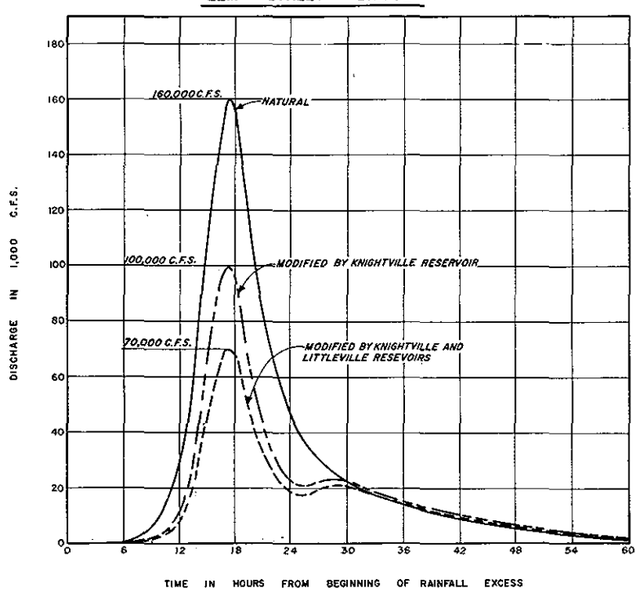
REGULATION AT LITTLEVILLE RESERVOIR



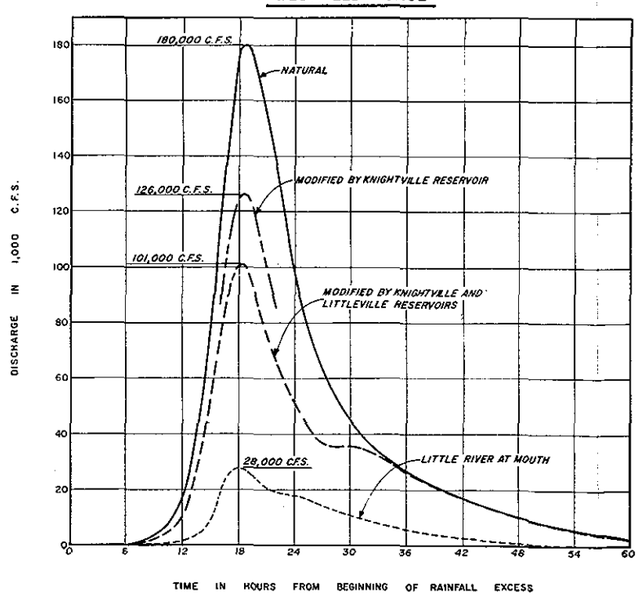
REGULATION AT KNIGHTVILLE RESERVOIR



WESTFIELD RIVER AT ELM STREET BRIDGE



WESTFIELD RIVER AT WESTFIELD GAGE



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
E.P.S.	M.W.B.	E.P.S.

SUBMITTED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF, HYD. & HYD. SECTION
APPROVAL RECOMMENDED:
CHIEF PLANNING & REPORTS BR.

CONNECTICUT RIVER FLOOD CONTROL

WESTFIELD RIVER WATERSHED
RESERVOIR REGULATION
STANDARD PROJECT FLOOD
MIDDLE BRANCH WESTFIELD RIVER, MASS.

APPROVED:
DATE APRIL 1961
CHIEF ENGINEERING DIVISION

SCALE AS NOTED

DRAWING NUMBER
CT-I-4572

SHEET 1 OF 1

PLATE H-46

ALL STATION SCAN 2 FEB. 1973

COASTAL STATION 40 BLOCK ISLAND	FILE NO. 54	DAY HR.MIN. 33 2055		TIDE 2.80 FT.	BAROMETER 29.03 IN. WARN		WIND VELOCITY 49 MPH	WIND DIRECTION 225 DEGR	
COASTAL STATION 41 OLD SAYBROOK	FILE NO. 52	DAY HR.MIN. 33 2055		TIDE 2.50 FT.	BAROMETER 29.12 IN. WARN		WIND VELOCITY 39 MPH	WIND DIRECTION 149 DEGR	
98									
STA. NO. AND NAME	FILE NO.	DAY HR.MIN.	DISCH.	CFS/SM	STAGE		CHNGSTG	RAIN	INCR.
38 WELLS RIVER	72	33 2055	7024.	2.7	4.60 FT.		0.0		
36 WEST HARTFORD	72	33 2056	840.	1.2	4.30 FT.		-0.1		
35 WHITE RIVER JUNCTION	69	33 2056	11590.	2.8	8.70 FT.		-0.1		
37 N WALPOLE	72	33 2056	14850.	2.7	10.90 FT.		0.0		
15 KEENE	72	33 2056	0.	0.0	69.50 FT.		0.4		
7 WEST DEERFIELD	73	33 2056	3234.	5.8	4.30 FT.		0.2		
6 MONTAGUE CITY	73	33 2056	21340.	2.7	14.10 FT.		0.8		
17 INDIAN ORCHARD	72	33 2056	1500.	2.2	6.10 FT.		0.0		
18 WESTFIELD	72	33 2056	1824.	3.7	6.10 FT.		-1.4		
16 SPRINGFIELD	72	33 2056	19600.	2.0	5.60 FT.		0.2		
27 MAD RIVER DAM	63	33 2057				NO REPORT			
24 COLLINSVILLE	72	33 2057	9000.	25.4	12.20 FT.	FSTG	5.7		
20 RAINBOW	72	33 2057	2210.	3.7	3.40 FT.		0.0		
19 HARTFORD	70	33 2057	20600.	2.0	7.20 FT.		0.4		
34 RUMNEY	71	33 2057	387.	2.7	3.50 FT.		0.1	15.67 IN.	0.36 WARN
33 WOODSTOCK	72	33 2057	3946.	20.4	6.70 FT.	WARN	1.4	4.03 IN.	0.37 WARN
39 CAMPTON	70	33 2057	422.	7.3	10.80 FT.		0.3	2.65 IN.	0.17
32 PLYMOUTH	72	33 2057	3450.	5.5	3.00 FT.	CHRG	0.1		
10 PENACOOK	73	33 2057	3520.	4.6	4.00 FT.		0.0		
3 SOUCOOK	69	33 2057	214.	2.8	6.80 FT.		0.1		
11 CONCORD	73	33 2058	6190.	2.6	5.30 FT.		0.1		
8 GOFFSTOWN	72	33 2058	782.	7.5	5.70 FT.		1.1		
9 GOFFS FALLS	73	33 2058	6832.	2.2	5.60 FT.		-0.1		
14 LOWELL	73	33 2058	27499.	5.9	48.20 FT.		0.1		
96									
28 HALL MEADOW DAM	72	33 2058	132.	7.7	7.40 FT.		2.0		
30 EAST BRANCH DAM	71	33 2058	119.	13.0	17.30 FT.		6.7	5.80 IN.	0.22
26 THOMASTON DAM	72	33 2058	996.	10.2	26.80 FT.		11.9		
31 NORTHFIELD BRK. LAKE	72	33 2058	89.	15.7	28.60 FT.		9.7		
25 BLACK ROCK LAKE	72	33 2058	345.	15.2	39.10 FT.		9.1		
23 HANCOCK BROOK LAKE	72	33 2058	190.	15.9	8.60 FT.		0.8		
29 HOP BROOK LAKE	72	33 2059	288.	17.6	27.80 FT.		4.9		
22 BEACON FALLS	73	33 2059	6832.	26.2	9.20 FT.	FSTG	0.8		
21 STEVENSON	72	33 2059	15400.	10.0	11.60 FT.	WARN	2.5		
99									
13 NORTHBRIDGE	73	33 2059	-0.	0.0	-10.00 FT.	NVLD1			
12 WOONSOCKET	73	33 2059	2658.	6.4	5.30 FT.		0.9		
2 WEBSTER	73	33 2059	574.	6.7	6.60 FT.	WARN	0.2		
4 JEWETT CITY	73	33 2059	4290.	6.0	10.20 FT.		0.2		
1 WILLIMANTIC NATCH.P.	73	33 2059	3602.	9.0	7.10 FT.	WARN	1.2	14.06 IN.	0.55 WARN

PLATE H-47

SAMPLE TELETYPE TO LITTLEVILLE LAKE

STATION NAME	NOTE	STA.	DAY	TIME	STAGE	DISCH.	RAIN
* * * * * * * * * * * * * * *		0	49	1907	18.00	6	0.26
WEBSTER	* *	2	49	1903	5.70	304	
WILLIMANTIC	* *	1	49	1904	4.90	1630	3.24
* * * * * * * * * * * * * * *		1	50	0113	19.00	3	0.24
WEST DEERFIELD	* CHRG *	7	50	0100	3.70	2172	
MONTAGUE CITY	* *	6	50	0101	14.80	23720	
SPRINGFIELD	* *	16	50	0101	6.20	23200	
HARTFORD	* *	19	50	0101	8.40	25000	
INDIAN ORCHARD	* NRPT *	17	49	1901	7.00	2350	
WESTFIELD	* *	18	50	0101	6.70	2360	
RAINBOW	* *	20	50	0101	3.70	2630	
COLLINSVILLE	* *	24	50	0101	6.60	1626	
MAD RIVER DAM	* NVLD *	27	50	0101	2.40	0	
JEWETT CITY	* *	4	50	0104	8.70	371	
WEBSTER	* *	2	50	0103	5.90	371	
WILLIMANTIC	* RAIN *	1	50	0104	5.10	1780	3.53
NORTHBRIDGE	* WARN *	13	50	0103	5.00	850	
WOONSOCKET	* *	12	50	0103	4.30	1900	

LOG OF RADIO REPORTS – FLOOD CONTROL DAMS

15 July 1977

WACHUSETT RELAY

Line	ITEM	66 WEST HILL	54 LITTLE-VILLE	53 KNIGHT-VILLE	51 BIRCH HILL	50 TULLY	52 BARRE FALLS	65 MANS-FIELD HOLLOW	62 EAST BRIM-FIELD	63 WEST-VILLE	64 WEST THOMP-SON	61 HODGES VILLAGE	60 BUFFUM-VILLE					BUZZARDS BAY 24 NEW BEDFORD BARRIER	Line
1	Time of Observation	0800	0800	0800	0800	0800	0800	0800	0800	0800	0800	0800	0800						1
2	Precipitation(last 24 hrs.)	0	0	0	-	-	0	0	0	0	0	0	0						2
3	Form of Precipitation	-	-	-	-	-	-	-	-	-	-	-	-						3
4	Present Weather	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear						4
5	Pool Stage	2.18	518.83	2.4	1.825	15.0	777.97	17.15	13.29	10.57	15.66	3.02	11.02						5
6	Tendency	Steady	Falling	Falling	Steady	Rising	Steady	Steady	Rising	Steady	Steady	Rising	Steady						6
7	Gate Openings	3-0-3	3-3	3-3-3	4-4-4-4	0-.15	3-3	F-.1-0-0-0	2-2-.1	0-F-.1	.1-1-0	3-3	.1-F-F						7
8	Tailwater Gage	1.37	2.00	2.87	4.15	2.76	2.37	2.1160	2.83	3.67	2.64	1.13	15						8
9	Outflow	9	60	189	89	17	8	155	43	65	118	19							9
10	INDEX POINTS	4.1	OUT		4.3		3.54	3.1				4.65							10
11		526	4.3				94	541				36							11
12		1.64	580																12
13		263																	13
14																			14
15																			15
	REMARKS 1 1/2" Alert																		

NED FORM OCT 75 477(A)

PLATE H-49

NED FORM APR 65 503

REGULATION OF LITTLEVILLE AND KNIGHTVILLE RESERVOIRS

RCS NEDED-3

LOG OF REPORTS AND INSTRUCTIONS

DATE AND TIME OF REPORT	LITTLEVILLE RES.												KNIGHTVILLE RES.							PRECIPITATION				W. Branch RIVER AT Huntington			Westfield RIVER AT Westfield			Connecticut RIVER AT Montague City					
	RES POOL		GATE OPENING								OUTFLOW		RES POOL		GATE OPENING			OUTFLOW					INCHES												
	HOUR	STAGE	1	2	3	4	5	6	7	8	T.W.	C.F.S	HOUR	STAGE	1	2	3	T.W.	C.F.S.	LOCATION	HOUR	INC	ACC.	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S
3/13/77	1445	523.6	3	3							4.0	612	1445	48.2	2	2	2	5.12	1968	Littleville	1445		1.2		5.8	3840		8.5	4340						
																				Knightville	"		1.10											
"	1800	526.5	3	3							4.11	658	1800	53.5	2	2	2	5.2	2080	Littleville	1800	.43	1.63		8.1	7520		9.5	5690						
																				Knightville	"	.40	1.50											
		GO TO	0	1										GO TO	1	0	1																	
3/14/77	0800	538.2	0	1							2.45	128	0800	78.9	1	0	1	4.17	905	Knightville	0800	.25	1.75		6.8	5320		11.4	8610						
		GO TO	0	.1										GO TO	0	0	.1			Littleville	0800	.35	1.98											
"	1315	541.4	0	.1							1.3	10	1315	84.4	0	0	.1	2.22	49															
														GO TO	0	2	0																	
"	1500	542.1	0	.1							1.3	10	1500	86.2	0	2	0	4.2	930						6.7	5160								
"	1900	543.8	0	.1							1.31	10	1900	89.2	0	2	0	4.23	957						5.9	3970		9.9	6290		32.7	104700			
3/15/77	0800	547.4	0	.1							1.16	5	0800	94.4	0	2	0	4.25	975						4.2	2040		8.4	4222		32.9	119300			

PLATE H-50

15 Nov. 1951

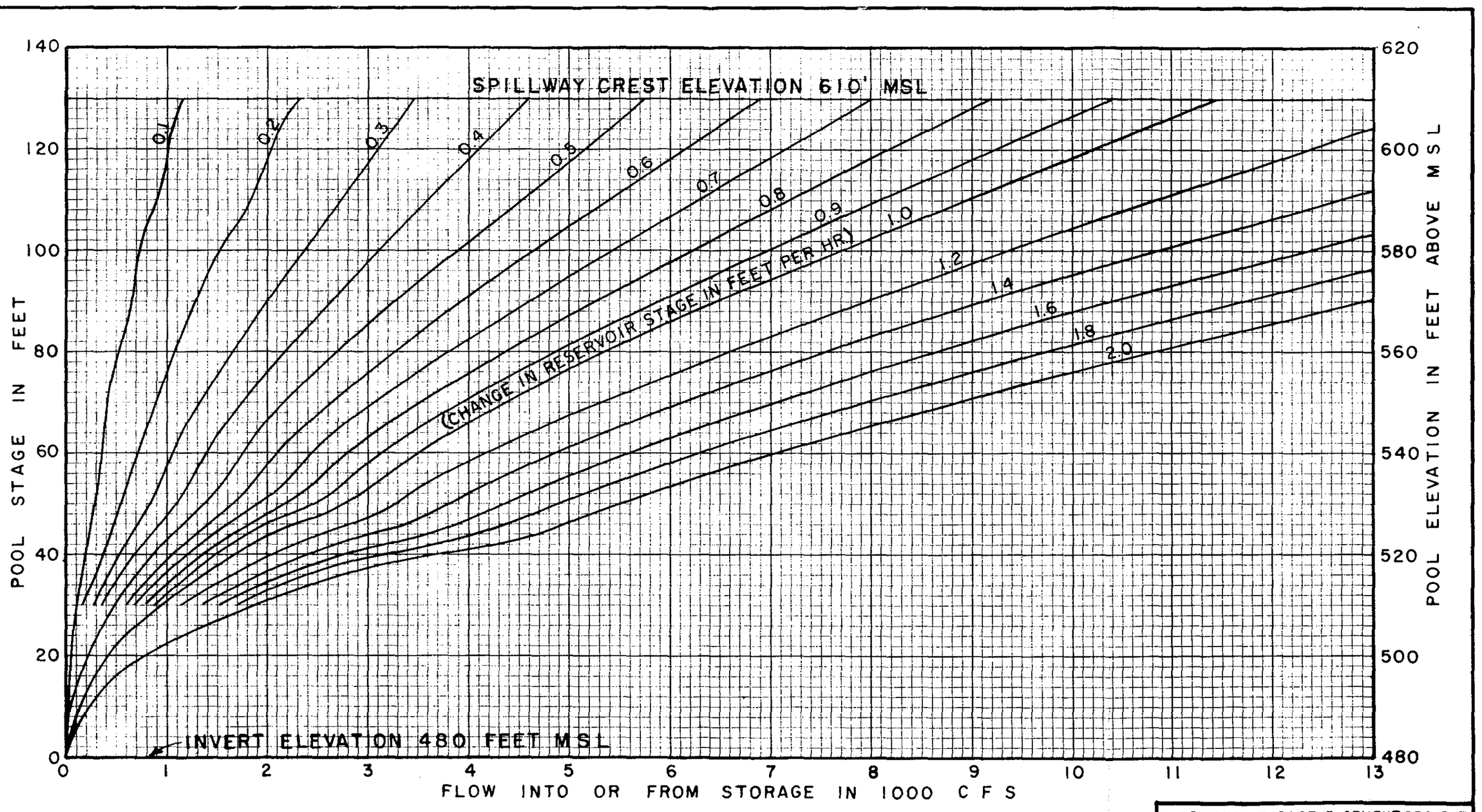
COMPUTATION OF INFLOW

Flood of MARCH 20 & 21

Reservoir KNIGHTVILLE By N. FORBES Date 24 MARCH 1975

TIME	RES. STAGE Feet	CHANGE IN RES. STAGE Feet per hour		FLOW into/from STORAGE c.f.s.	OUTFLOW c.f.s.	TOTAL INFLOW (5) + (6) c.f.s.	REMARKS
		Observed	Adjusted				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3-20-75							
2400	24.0				348		
	26.1	4.2	2.1	1510	210	1720	
0200	28.2				71		
	30.6	4.8	2.4	2700	71	2770	
0400	33.0				71		
	35.8	5.6	2.8	3700	71	3770	
0600	38.6				71		
	41.8	6.4	3.2	6100	71	6170	
0800	45.0				71		
	47.4	4.8	2.4	6100	71	6170	
1000	49.8				71		
	51.5	3.4	1.7	4800	71	4870	
1200	53.2				71		
	54.8	3.2	1.6	4850	374	5220	
1400	56.4				676		
	57.8	2.8	1.4	4700	676	5380	
1600	59.2				676		
	60.4	2.4	1.2	4200	1030	5230	
1800	61.6				1385		
	62.6	2.0	1.0	3700	1385	5090	
2000	63.6				1385		
	64.5	1.9	1.0	3650	1385	5040	
2200	65.5				1385		
3-21-75	66.2	1.3	0.65	2550	1385	3940	
2400	66.8				1385		
	67.4	1.1	0.55	2250	1385	3640	
0200	67.9				1385		
	68.3	0.8	0.4	1700	1385	3085	
0400	68.7				1385		
	69.1	0.7	0.4	1500	1385	2880	
0600	69.4				1385		
	69.7	0.5	0.25	1100	1385	2480	
0800	69.9				1385		
	69.8	-0.1	-0.05	-200	2100	1900	
1000	69.9				2820		
	69.7	-0.2	-0.1	-400	2820	2420	
1200	69.6				2820		

PLATE H-51



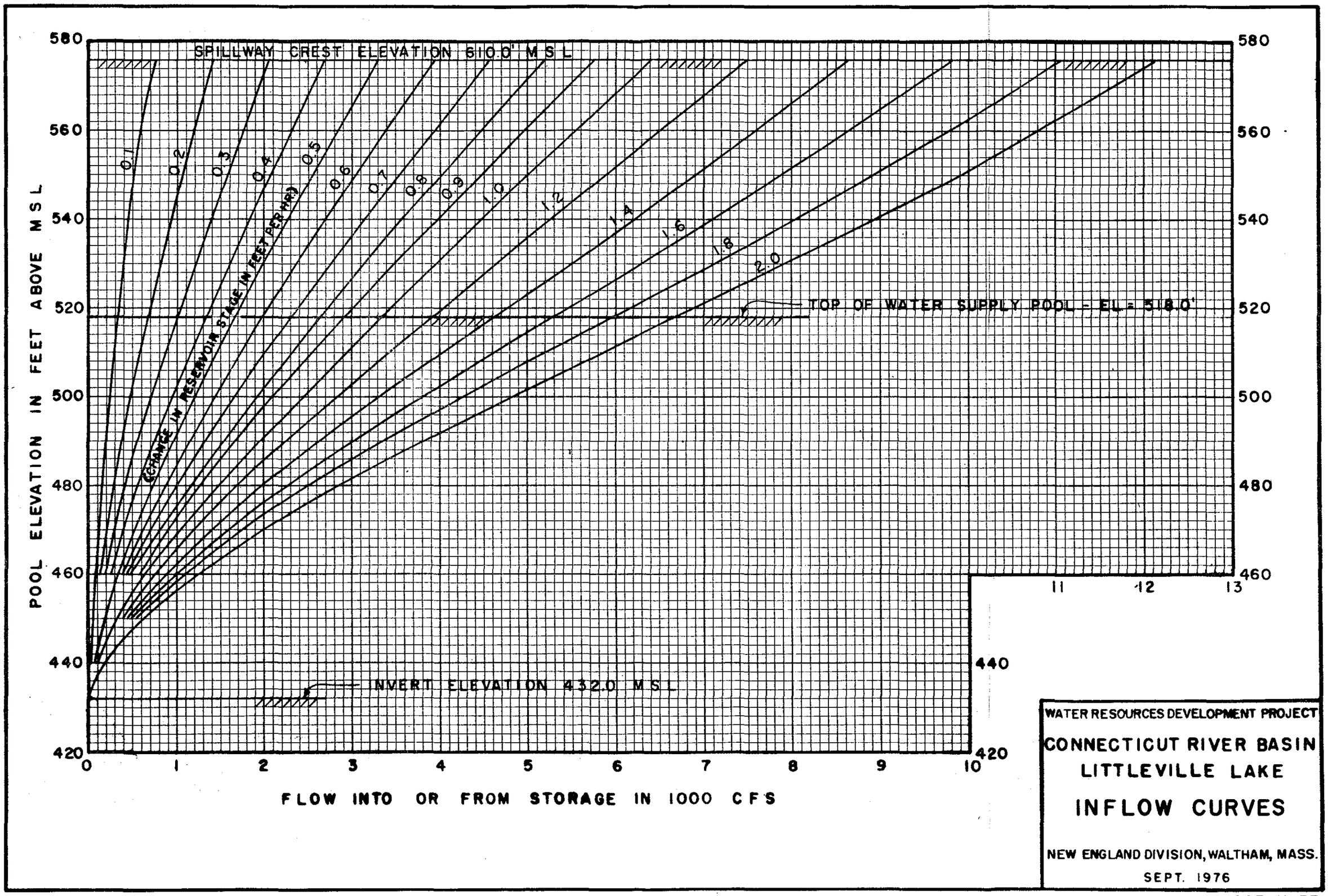
WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
KNIGHTVILLE DAM

INFLOW CURVES

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-52



WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN

LITTLEVILLE LAKE

INFLOW CURVES

NEW ENGLAND DIVISION, WALTHAM, MASS.

SEPT. 1976

PLATE H-53

GATE OPERATION RECORD

Littleville RESERVOIR March MONTH 77 YEAR

OPERATOR

I.D.	DAY	HOUR	RES. STAGE	OUTFLOW	PRECIP.	T.W.	GATE SETTING 1	2	3	4	5	6	7	8	REMARKS
52	12	0800	520.78	490	.	369	3	3							
	13	0800	521.66	532	.32	380									Rain
	13	1800	526.47	658	.	411	1	0							Gate Chg.
	13	1900	526.50	130	.										
	14	0800	538.18	130	1.66	245	1	0							Rain
52	14	0900	538.73	130	.		1	1							Gate Chg.
	14	1000	538.90	200	.		2	2							
	15	0800	547.35	200	.09	116	0	0							Rain
52	15	0900	547.55	10	.		1	0							Gate Chg.
	15	1300	548.25	10	.		2	1							" "
	15	1400	548.26	650	.		2	2							" "

STANDARD OPERATING PROCEDURE (SOP)

FLOOD CONTROL REGULATION

KNIGHTVILLE DAM AND LITTLEVILLE LAKE

PHASE	STORM RAINFALL (WITHIN 24-HR. PERIOD) ANTECEDENT CONDITIONS		KNIGHT-VILLE DAM	LITTLE-VILLE LAKE	RIVER INDEX STATIONS (STAGE IN FEET)					REGULATION INSTRUCTIONS GATE SETTINGS		DUTIES DURING EACH PHASE
					WESTFIELD RIVER AT		CONNECTICUT RIVER AT					
	SNOW-COV'R'D WET OR FRO-ZEN GROUND	DRY GROUND	POOL STAGE FEET	POOL STAGE FT. MSL	HUNTING-TON W. BRANCH 93.7 SQ. MI.	WEST-FIELD 497 SQ.MI.	MONTAGUE CITY 7,865 SQ. MI.	SPRING-FIELD 9587 SQ. MI.	HART-FORD 10,428 SQ. MI.	KNIGHT-VILLE DAM	LITTLE-VILLE DAM	
I - APPRAISAL												FLOOD CONTROL PROJECT MANAGER
FIRST ALERT	1.0"	1.0"	SUMMER 25'(RISING) WINTER 30'(RISING)	522 (RISING)	3.8'(RISING) (1640 CFS)	8.0'(RISING) (3720 CFS)	22.0'(RISING) (50,800 CFS)	12.0'(RISING) (66,000 CFS)	16.0'(RISING) (66,000 CFS)			PHASE I 1. COLLECT AND TRANSMIT RAINFALL AND STAGE DATA TO RCC. 2. OPERATE ACCORDING TO INSTRUCTIONS FROM RCC.
SECOND ALERT	1.5"	2.0"	As Instructed	As Instructed	5.0'(RISING) (2880 CFS)	9.0'(RISING) (4990 CFS)	25.0'(RISING) (64,000 CFS)	16.0'(RISING) (104,000 CFS)	17.0'(RISING) (71,000 CFS)	3'-3'-3'	3'-3'	PHASE II 1. OPERATE ACCORDING TO INSTRUCTIONS FROM RCC. 2. NOTE ALL UNUSUAL CONDITIONS AT DAM, DOWNSTREAM CHANNELS AND INDEX STATIONS. 3. COLLECT AND TRANSMIT RAINFALL AND STAGE DATA AT MINIMUM 3-HOUR INTERVALS OR AS DIRECTED BY RCC.
INITIAL REGULATION	2.0" (Or As Instructed)	3.0"	As Instructed	As Instructed	6.0(RISING) (4100 CFS)	12.0 (RISING) (9570 CFS)	26.0(RISING) (68,800 CFS)	16.0(RISING) (104,000 CFS)	16.0(RISING) (66,000 CFS)	1'-1'-1'	1'-1'	
II - CONTINUATION OF REGULATION	3.0" (Or As Instructed)	4.0"	As Instructed	As Instructed	6.6 (RISING) (5000 CFS)	14.0(RISING) (13070 CFS)	28.0(RISING) (79,000 CFS)	18.0(RISING) (126,000 CFS)	18.0(RISING) (80,000 CFS)	RESTRICT OUTFLOW TO MINIMUM 0-0-0.1'	RELEASES 0-0.1'	PHASE III 1. CONTINUE PHASE II, STEP 3. 2. RECONNOITER DOWNSTREAM CHANNELS AND POTENTIAL DAMAGE AREAS. 3. REPORT TO RCC FOR FURTHER INSTRUCTIONS.
III - EMPTYING THE RESERVOIRS	STORM HAS ABATED		THE NON-DAMAGING DOWNSTREAM CAPACITIES ARE AS FOLLOWS: KNIGHTVILLE DAM - 4500 + CFS LITTLEVILLE DAM - 1700 + CFS									PROJECT REGULATOR PHASE I 1. COMPILE DATA. 2. PLAN AND COORDINATE NEXT TRANSMISSION TO PROJECT MANAGERS. 3. RESTRICT OUTFLOW TO MAINTAIN SAFE DOWNSTREAM CHANNEL CAPACITIES. 4. INFORM CONNECTICUT RIVER BASIN REGULATOR OF ACTIONS. PHASE II 1. CONTINUE REGULATION INSTRUCTIONS TO PROJECT MANAGERS. 2. CONSULT WITH BASIN REGULATOR TO ANALYZE SEVERITY OF FLOOD. 3. COORDINATE REGULATION WITH CONNECTICUT RIVER BASIN REGULATOR. PHASE III 1. COLLECT DATA FROM PROJECT MANAGERS. 2. CONSULT WITH CONNECTICUT RIVER BASIN REGULATOR. 3. TRANSMIT INSTRUCTIONS TO PROJECT MANAGERS.

EMERGENCY OPERATION PROCEDURE (E.O.P)

(During Communications Failure with RCC)

	PARTIAL CLOSURE	COMPLETE CLOSURE
Knightville	1'-1'-1'	0-0-0.1'
Littleville	1'-1'	0-0.1'

Precipitation in 24 Hours		
Wet Ground	1.5"	2.0"
Dry Ground	2.0"	3.0"
Rising Stages		
W. Branch @ Huntington	4'	5' and Rising
Westfield River @ Westfield	9'	10' and Rising
Montague City	26'	29' and Rising
Hartford	19'	20' and Rising

NOTES:

1. EMPTYING THE RESERVOIR SHALL NOT BE INITIATED UNTIL CONTACT HAS BEEN ESTABLISHED WITH RCC.

2. THE RATE OF RESERVOIR DISCHARGE FROM KNIGHTVILLE DAM SHALL NOT EXCEED 500 CFS/HR UP TO 2500 CFS AND 250 CFS/HR OVER 2500 CFS. THE RATE OF INCREASE FROM LITTLEVILLE LAKE SHALL NOT EXCEED 300 CFS/HR UP TO 1200 CFS AND 100 CFS/HR OVER 1200 CFS.

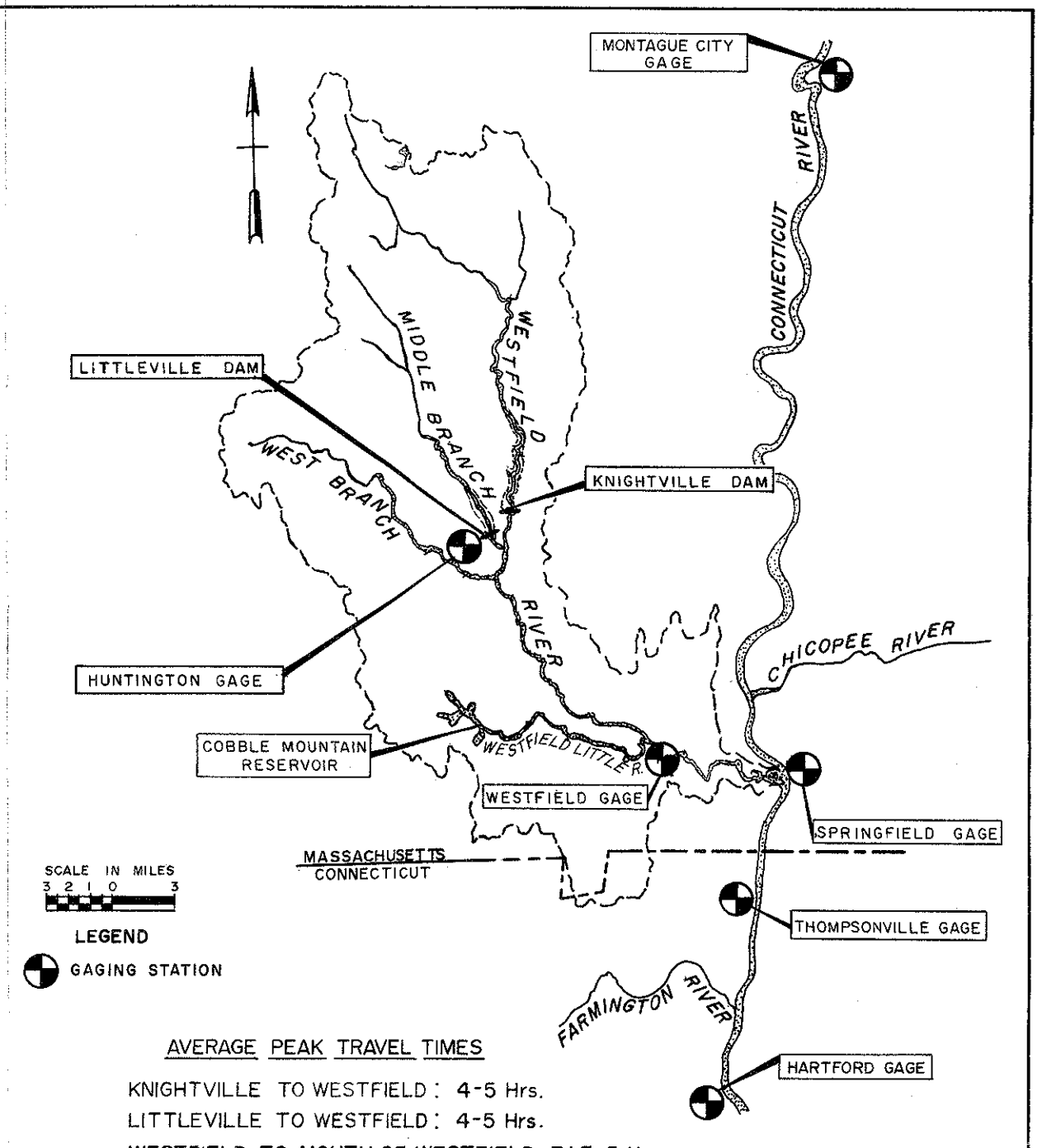
3. MAXIMUM RATE OF RESERVOIR DRAWDOWN SHALL NOT EXCEED 15 FEET IN 24 HOURS AT KNIGHTVILLE OR 5 FEET IN 24 HOURS AT LITTLEVILLE.

4. FLOOD STAGES AT THE ABOVE RIVER INDEX STATIONS ARE AS FOLLOWS: WESTFIELD - 14 FEET, SPRINGFIELD - 20 FEET AND HARTFORD - 22 FEET. (AGRICULTURAL LANDS ADJACENT TO THE CONNECTICUT RIVER START TO BECOME INUNDATED WHEN HARTFORD STAGES RISE ABOVE 16 FEET.)

5. CONSIDER ROAD CLOSURES AT KNIGHTVILLE WHEN A RISING POOL IS EXPECTED TO REACH 40 FEET.

6. EVACUATION OF INDIAN HOLLOW CAMPING AREA AT KNIGHTVILLE SHOULD BE CONSIDERED WHEN A RISING POOL REACHES 80-FOOT STAGE.

7. REFER TO CHAPTER V, RESERVOIR REGULATION, FOR SNOWMELT REGULATION AND REGULATION DURING ICE JAM FLOODING.



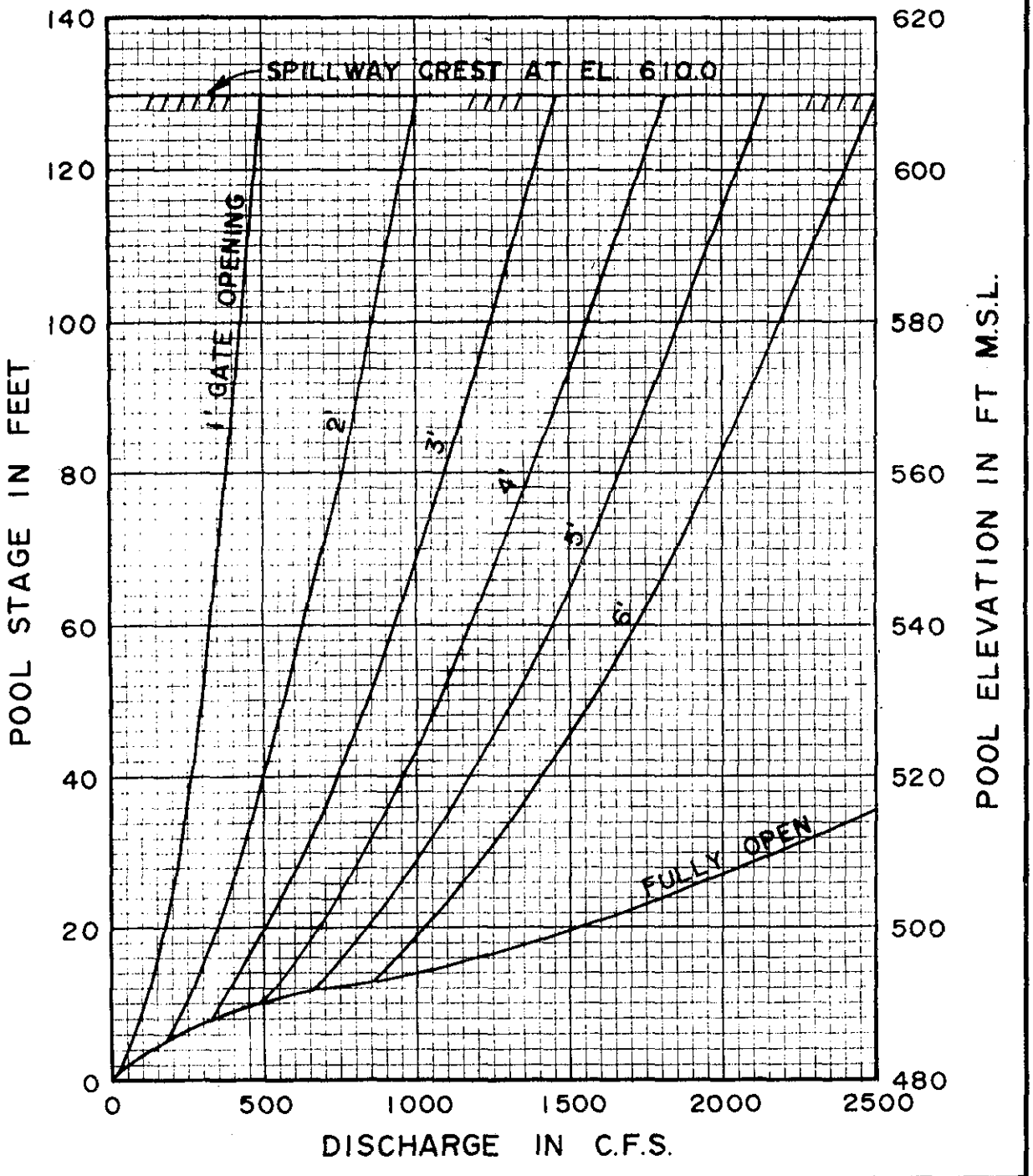
AVERAGE PEAK TRAVEL TIMES

KNIGHTVILLE TO WESTFIELD: 4-5 Hrs.
LITTLEVILLE TO WESTFIELD: 4-5 Hrs.
WESTFIELD TO MOUTH OF WESTFIELD R: 3-5 Hrs.
MONTAGUE CITY TO SPRINGFIELD: 12-15 Hrs.
SPRINGFIELD TO HARTFORD: 15-20 Hrs.

DISTANCE IN RIVER MILES

MONTAGUE CITY TO SPRINGFIELD	50 MILES
SPRINGFIELD TO THOMPSONVILLE	7 MILES
THOMPSONVILLE TO HARTFORD	16 MILES

PLATE H-55



NOTE:

3 GATES, EACH
6 FT. WIDE × 12 FT. HIGH
16 FT. DIAMETER CONDUIT

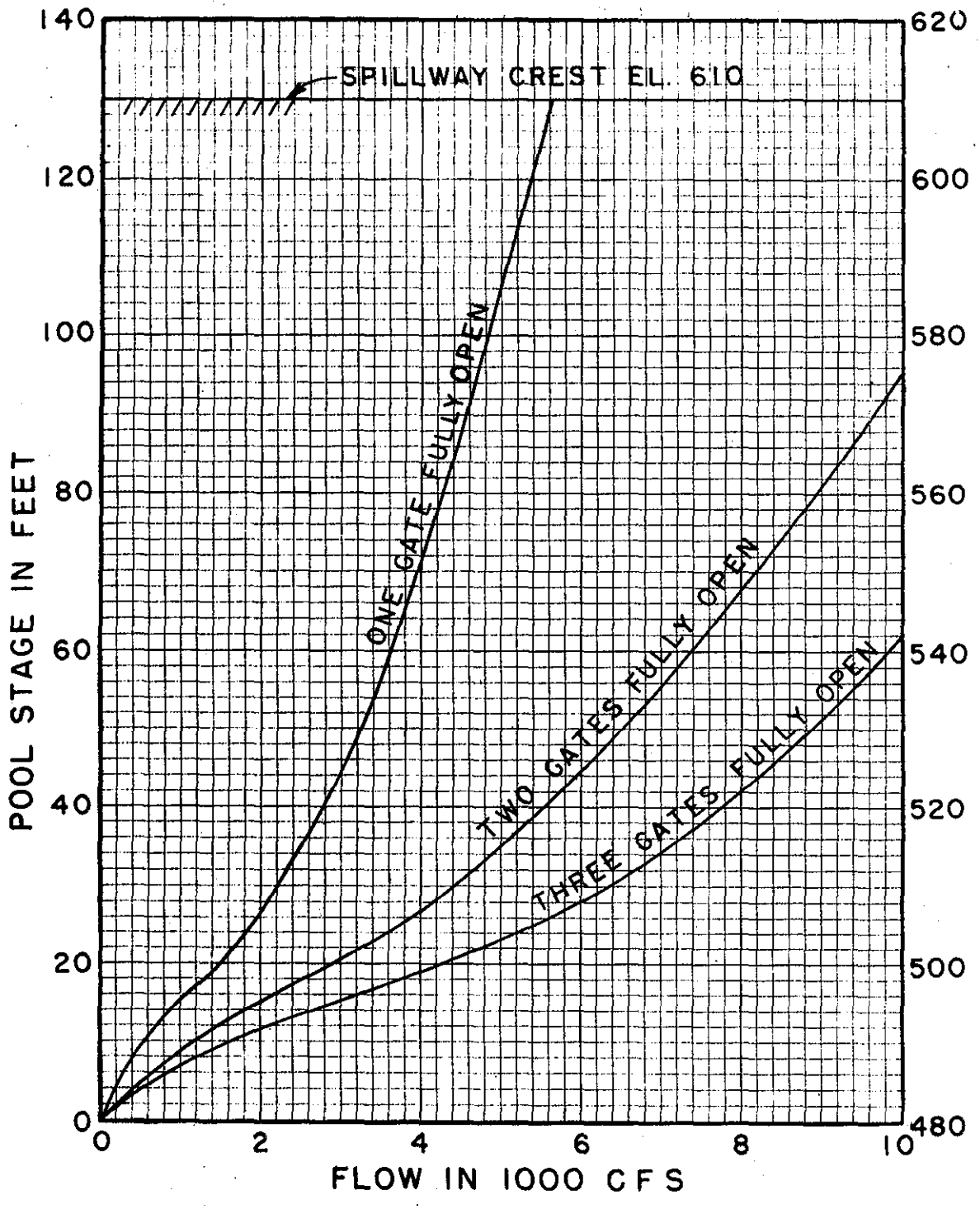
WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
KNIGHTVILLE DAM

OUTLET RATING CURVES FOR ONE GATE

NEW ENGLAND DIVISION, WALTHAM, MASS.
MAY 1977

PLATE H-56



NOTES:

THREE GATES, EACH 6 FT. WIDE x 12 FT. HIGH.
16 FT. DIAMETER CONDUIT.

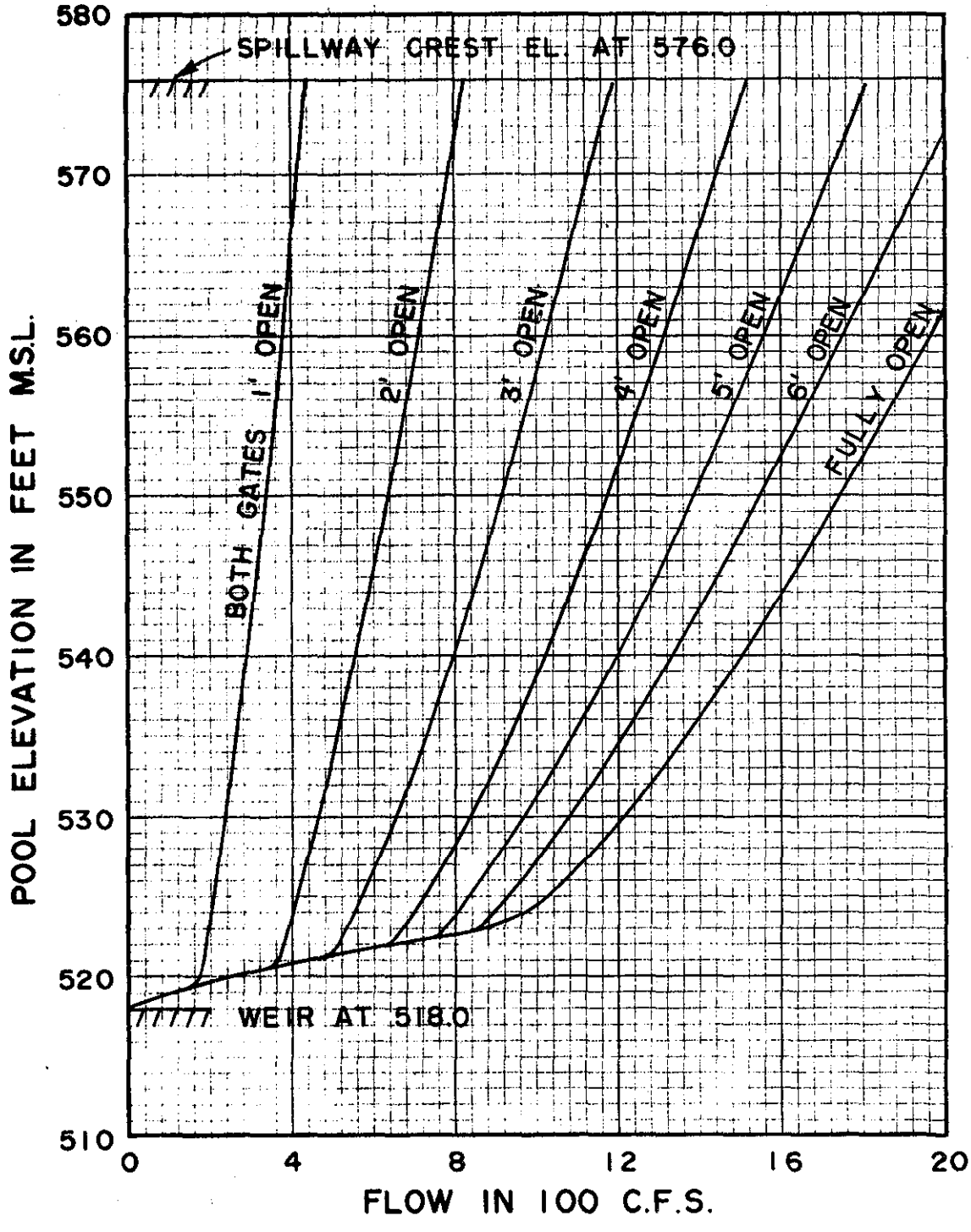
WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
KNIGHTVILLE DAM

OUTLET RATING CURVES FOR THREE GATES

NEW ENGLAND DIVISION, WALTHAM, MA.
MAY 1977

PLATE H-57



NOTE:
TWO FLOOD CONTROL GATES
EACH 4 FT. WIDE x 8 FT. HIGH.
8 FT. WIDE HORSESHOE
CONDUIT

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
LITTLEVILLE LAKE

OUTLET RATING CURVES FOR TWO GATES

NEW ENGLAND DIVISION, WALTHAM, MASS.
MAY 1977

PLATE H-58

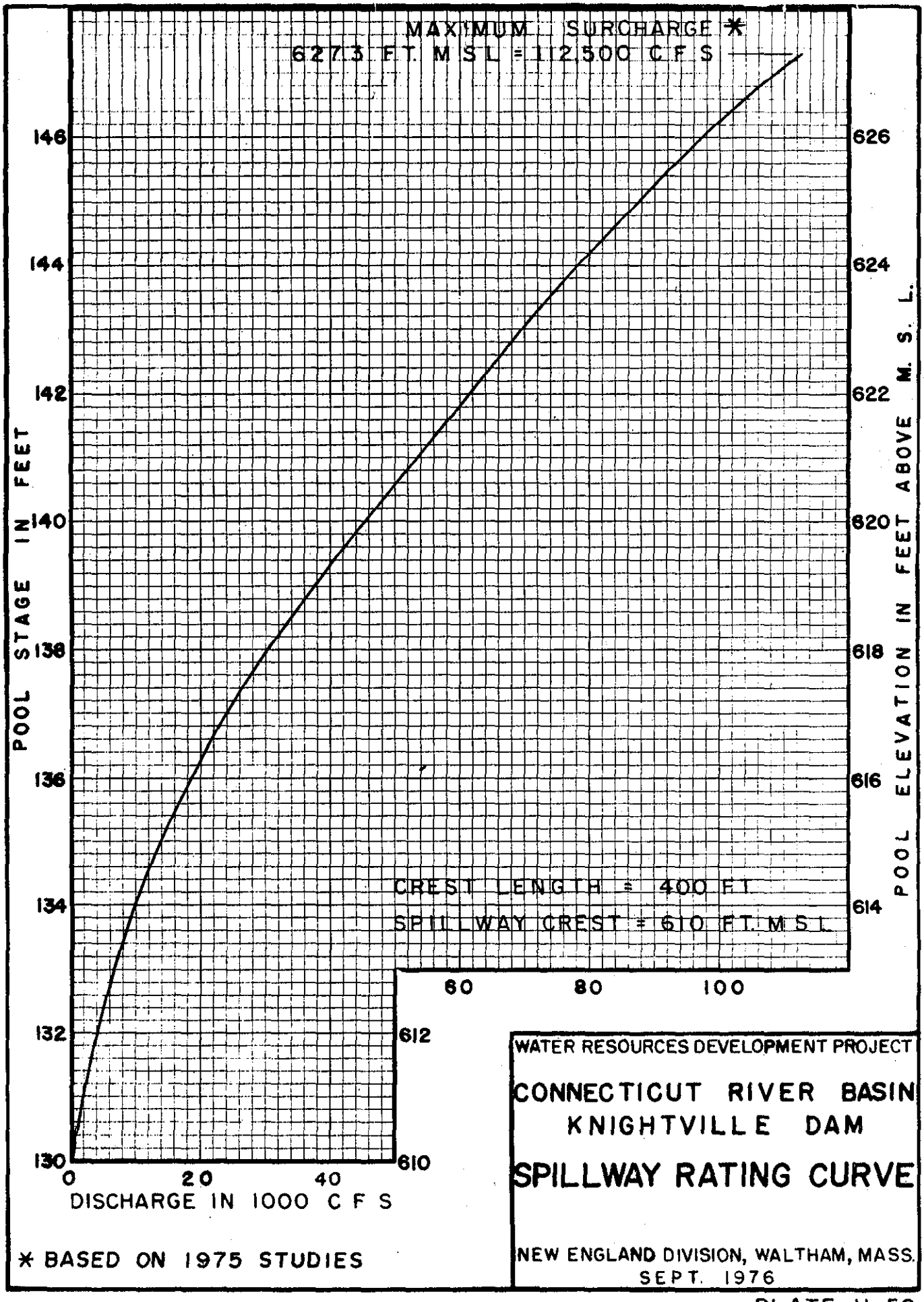
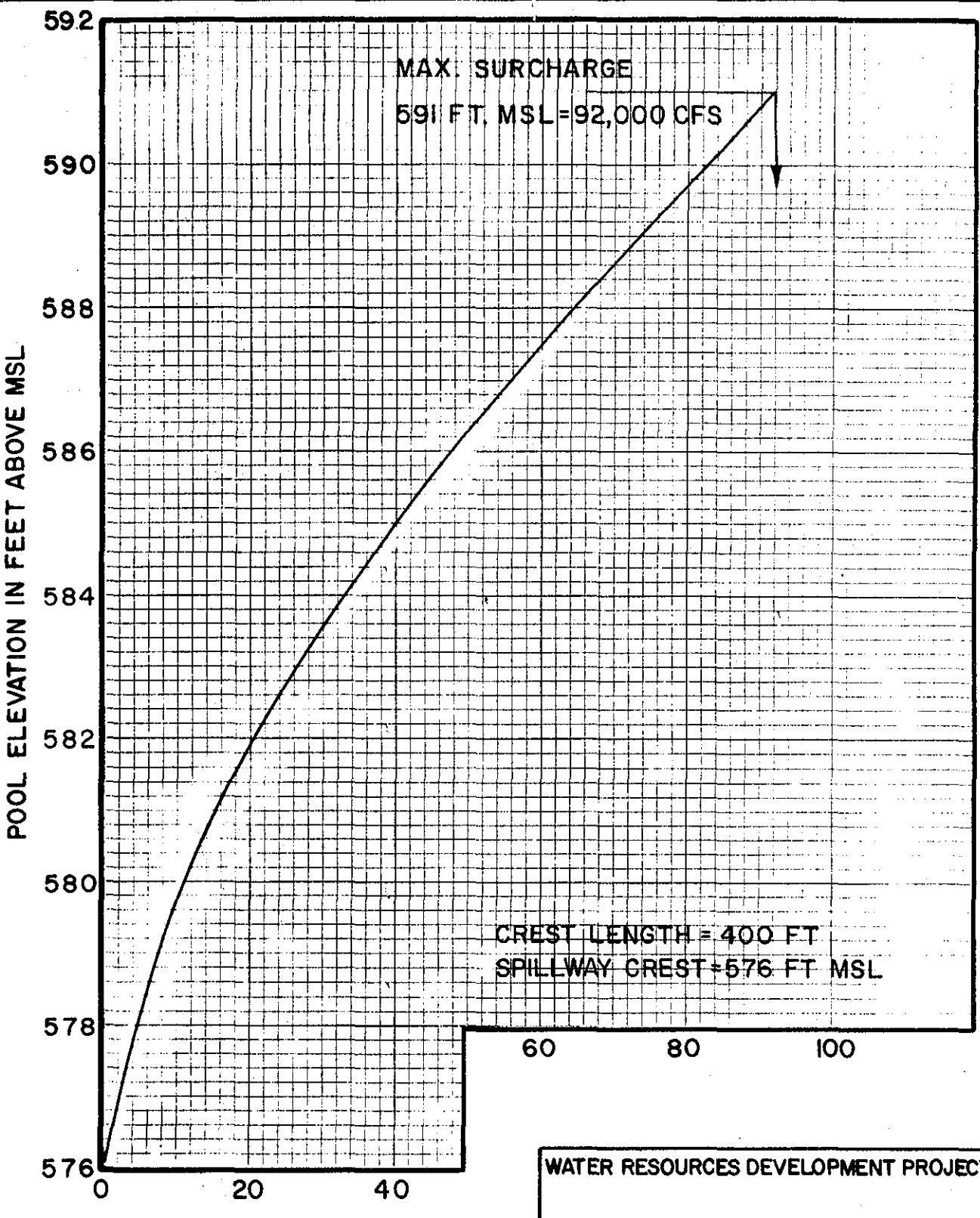

MAXIMUM SURCHARGE *
627.3 FT. M S L = 112,500 C F S
146
144
142
140
138
136
134
132
130
626
624
622
620
618
616
614
612
610
POOL STAGE IN FEET
POOL ELEVATION IN FEET ABOVE M. S. L.
CREST LENGTH = 400 FT.
SPILLWAY CREST = 610 FT. M S L.
60
80
100
0
20
40
DISCHARGE IN 1000 C F S
* BASED ON 1975 STUDIES
WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
KNIGHTVILLE DAM
SPILLWAY RATING CURVE
NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-59



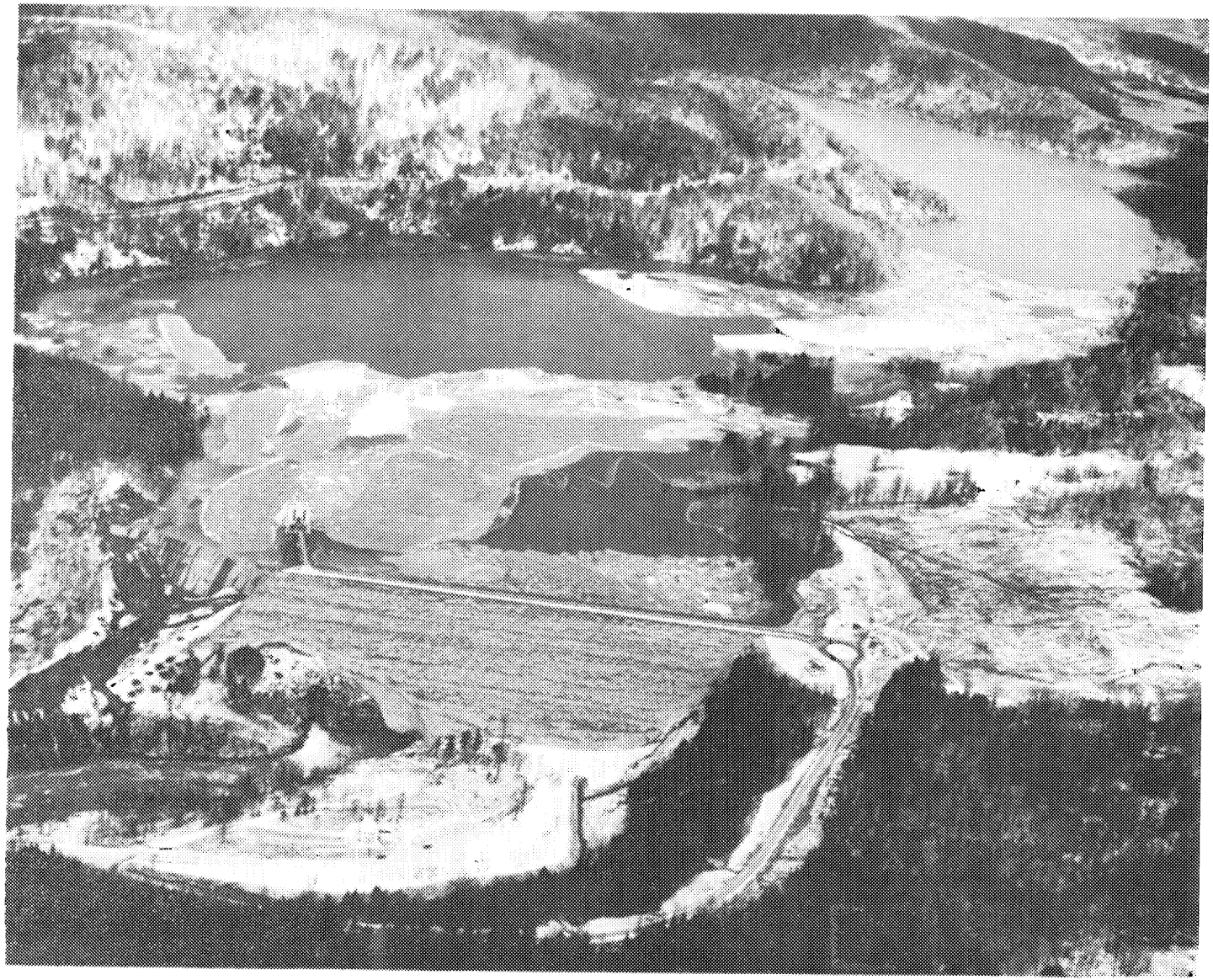
WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
LITTLEVILLE LAKE

SPILLWAY RATING CURVE

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1976

PLATE H-60



KNIGHTVILLE DAM - POOL ELEVATION 610
FLOOD OF DECEMBER 1948 - JANUARY 1949

VIEW OF LITTLEVILLE LAKE

ATTACHMENT "A"

LITTLEVILLE LAKE WATER SUPPLY FACILITIES

OPERATION AND DESCRIPTION

ATTACHMENT "A"
WATER SUPPLY

TABLE OF CONTENTS

LIST OF PLATES

ATTACHMENT "A"

1. GENERAL

The important physical components of the water supply system consist of an intake tower, a 48-inch concrete pipeline inside an arch-shaped conduit 800 feet in length and 9 feet in width, and a low flow diversion structure. Plate 1 of this attachment includes a site plan of the water supply system.

2. INTAKE TOWER

The water supply intake tower is located at the upstream toe of the dam adjacent to the old streambed. The tower is a wet well with four 36-inch diameter gates at different elevations so that water can be selectively withdrawn. The 36-inch sluice gates are on the inside face of the tower and are controlled by motor-operated hoists in the operating room, which has a floor elevation of 597.0. These gates, numbered from 1 to 4, are located at the following elevations:

Gate	Invert Elevation
Top of water supply reservoir	518.0
1	502.2
2	483.8
3	465.4
4	447.0

These gates will ordinarily remain wide open which means the water level in the tower is about the same as the reservoir.

Gate 5 is a 48-inch butterfly valve with invert at elevation 432.0 which allows water to discharge from the intake tower into the 48-inch pipeline. This gate will ordinarily be fully open and controlled by a motor-operated hoist at floor elevation 584 feet msl. Rating curves for the water supply gates are shown on plate 2 of this attachment.

The basement of the tower contains two other gated openings.

One gate is a 48-inch sluice for a 48-inch square opening in the upstream face of the tower. This gate, which is normally closed, is on the inside face and controlled by a manually operated hoist located on the floor at elevation 446.0. The gate was installed to permit drainage of the lake and should be cracked open for inspection purposes whenever the pool is at or below elevation 446 feet.

The other gate is a 12-inch sluice ("mud gate") on a 12-inch diameter pipe. The gate, on the inside face of the downstream side of the tower, is controlled by a manually operated wheel at floor elevation 446.0. The 12-inch pipe (invert 432.0) goes through the tower wall and into the diversion tunnel to allow drainage of the tower. The gate is presently cracked open to allow a small flow and prevent stagnation of water in the tower. This small flow seeps out of the diversion tunnel and into the ground at the old outlet portal. The flow eventually discharges into the river at the diversion structure.

3. WATER SUPPLY PIPELINE

The 48-inch diameter concrete pipe was constructed inside the 9-foot arch-shaped concrete diversion conduit, and extends to a pumping station in Huntington. A low flow diversion structure and a 48-inch hand-operated gate valve on the 48-inch pipeline is located 215 feet downstream of the toe of the dam. The pipeline between the dam and the pumping station contains several air valves to remove air trapped in the line and admit air to the line to prevent its collapse under vacuum.

The 48-inch valve downstream of the dam is normally fully open. The pipeline is therefore under pressure from the dam to the pumping station. A hydrant system is connected to the pipeline at a school in Huntington for fire protection purposes. In the event it is necessary to close the 48-inch valve at the diversion structure, the Huntington Fire Department will be notified in advance by the Project Manager.

The city of Springfield, in anticipation of a dam and reservoir at Dayville, 3 miles upstream of Littleville, has extended the 48-inch pipe through the tower to the upstream face and sealed it with a cast iron bulkhead.

4. LOW FLOW DIVERSION STRUCTURE

This structure is located about 215 feet downstream of the dam and adjacent to the 48-inch pipeline. Within the structure is a 12-inch pipe for low flow augmentation and a 24-inch pipe to drain the lake below elevation 518 feet msl.

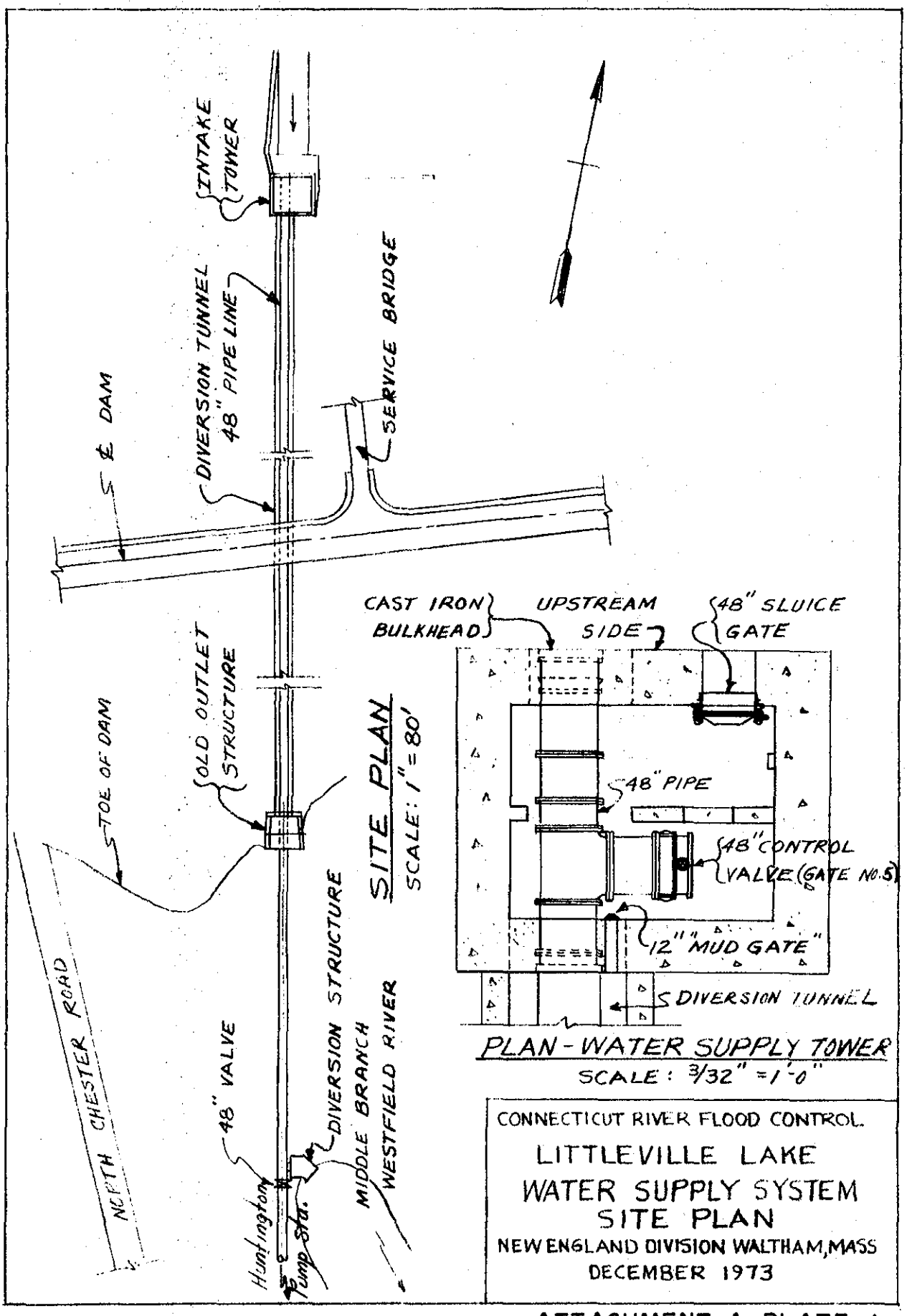
The 12-inch pipe contains a manually operated butterfly valve, a self-regulating valve set to discharge a selected minimum release, a flow meter and flow recorder. The 24-inch pipe also contains a manually operated butterfly valve. Plate 3 of this attachment includes a diagram of the structure.

5. INSPECTION

Yearly maintenance inspections of the water intake tower by Corps personnel require draining the tower. This is accomplished by closing gates 1, 2, 3 and 4 in the tower, closing the 48-inch hand-operated valve (near the diversion structure) and opening the 24-inch valve in the diversion structure.

6. MINIMUM DOWNSTREAM REQUIREMENTS

Section 10 in Chapter 628 from the Acts and Resolves of the Commonwealth of Massachusetts, authorizes the Massachusetts Water Resources Commission to fix and regulate low flow requirements from Littleville Lake after water supply diversions have been initiated. In a letter from the Massachusetts Water Resources Commission, dated 3 February 1969, a minimum flow of 5 cfs was established, subject to future reviews and re-evaluation.



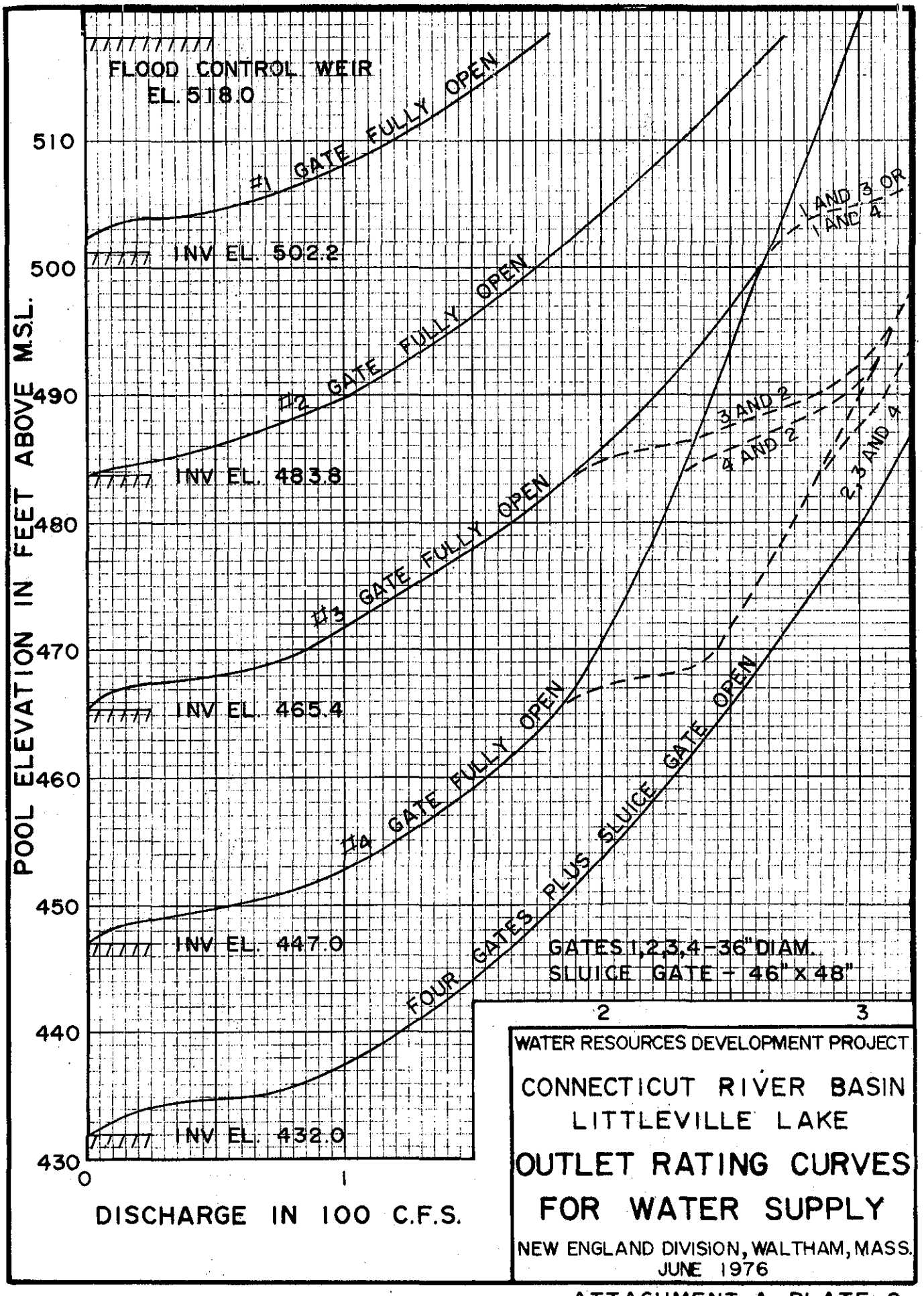
CONNECTICUT RIVER FLOOD CONTROL.

LITTLEVILLE LAKE WATER SUPPLY SYSTEM SITE PLAN

NEW ENGLAND DIVISION WALTHAM, MASS

DECEMBER 1973

ATTACHMENT A PLATE 1



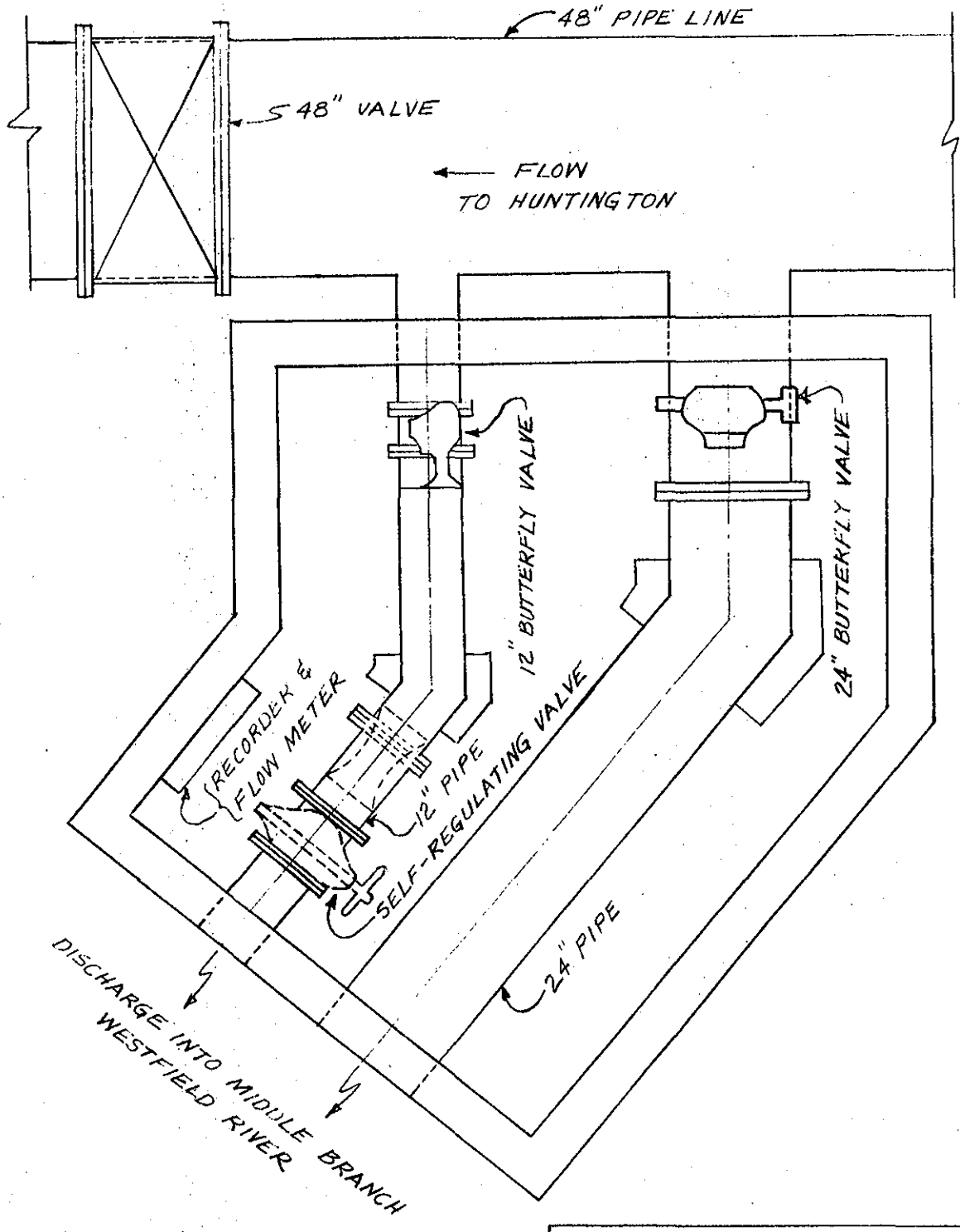
WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
LITTLEVILLE LAKE

OUTLET RATING CURVES FOR WATER SUPPLY

NEW ENGLAND DIVISION, WALTHAM, MASS.
JUNE 1976

ATTACHMENT A PLATE 2



DIVERSION STRUCTURE

SCALE: 3/8" = 1'-0"

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE LAKE

WATER SUPPLY SYSTEM
DIVERSION STRUCTURE

NEW ENGLAND DIVISION WALTHAM, MASS.

DECEMBER 1973

ATTACHMENT A PLATE 3

APPENDIX "A"

NOTE - This is a copy of the contract between the United States and the city of Springfield for water storage space in the Littleville Reservoir, entered into 13 December 1967.

CONTRACT BETWEEN THE UNITED STATES OF AMERICA AND THE CITY OF SPRINGFIELD FOR WATER STORAGE SPACE IN LITTLEVILLE RESERVOIR

THIS CONTRACT, entered into this 13th day of December, 1967, by and between the UNITED STATES OF AMERICA (hereinafter called the Government), represented by the Contracting Officer executing this contract, and THE CITY OF SPRINGFIELD, Massachusetts, (hereinafter called the City).

WITNESSETH THAT:

WHEREAS, the Flood Control Act of 1958 (72 Stat. 305) authorized the construction, operation, and maintenance of the Littleville Reservoir on the Middle Branch of the Westfield River, Massachusetts, (hereinafter called the "Project"); and,

WHEREAS, the City desires to contract with the Government for inclusion in the Project of storage for municipal and industrial water supply, and for payment for the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 390 b-f); and,

WHEREAS, the City is empowered so to contract with the Government, and is vested with all necessary powers for accomplishment of the purposes of this contract.

NOW, THEREFORE, THE PARTIES DO MUTUALLY AGREE AS FOLLOWS:

ARTICLE 1. WATER STORAGE SPACE

a. Upon making the first payment on the principal for the water storage space, as provided in Article 4, the City shall have the right

(1) to utilize such storage space in the Project between Elevation 518.0 feet above mean sea level and 432.0 feet above mean sea level for water supply for municipal and industrial use as deemed necessary by the City,

(2) to impound water in the Project and make such diversions as granted to the City by the Commonwealth of Massachusetts to the extent that such storage will provide, and

(3) to withdraw water from the aforesaid storage space or to order releases therefrom to be made by the Government at any time so long as the elevation of the water in the reservoir is above Elevation 432.0 feet above mean sea level.

b. The Government reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property.

c. The City shall have the right to construct, operate, and maintain such installations or facilities at the Project as it may deem necessary for the purpose of diversions or withdrawals, subject to the approval of the Contracting Officer as to design and location. The City shall bear all costs of construction, operation, and maintenance or replacements of such installations and facilities.

d. The City recognizes that this contract provides storage space for raw water only. The Government makes no representation with respect to the quality or availability of water and assumes no responsibility therefor, and for treatment of the water.

ARTICLE 2. METERING

For the purpose of maintaining an accurate record of water resources at the Project, the City, prior to use of the water storage space, agrees to install suitable meters or metering devices satisfactory to the Contracting Officer, without cost to the Government. The City shall furnish the Government monthly statements of the quantity of water withdrawn.

ARTICLE 3. REGULATION OF THE USE OF WATER

The regulation of the use of water stored in the aforesaid storage space shall be the responsibility of the City. The City has the full responsibility to acquire in accordance with State laws and regulations, and if necessary to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of storage space by the City, except as such controversies may affect the operations of the Government.

ARTICLE 4. CONSIDERATION AND PAYMENT

In consideration of the payments provided in this agreement to be paid by the City to the Government, the Government will provide storage space in the Project as provided in Article 1. In consideration of the Government providing the aforesaid storage space to the City, the City shall pay the following sums to the Government:

a. The sum of $2,202,160.48, which is the total estimated cost of providing water storage space, includes the amount of $173,079.00 for specific costs plus a percentage of the total joint-use cost amounting to $1,919,784.00 and interest during construction in the amount of $109,297.48. Payments shall be made in the following manner:

(1) A payment in the amount of $105,738.87 shall be made on 1 June 1968, and annually thereafter on 1 June of each year up to and including 1 June 1997. The date of 1 June 1968 is based on the assumption that the City will start drawing water on or about this date. The $105,738.87 is the annual payment necessary to liquidate the $2,202,160.48 estimate of cost of storage space in a period of 30 years with an interest rate of 2.742% per annum on the unpaid balance. In the event that the date of withdrawal of water is delayed beyond 1 June 1968, the schedule of payments for the storage shall be delayed to the same extent.

b. The aforesaid payments are more specifically set forth in Exhibit "B" attached hereto and made a part hereof, and the last payment of a.(1) above shall be adjusted upward and downward when due, to assure the repayment of all capital costs and interest within the 30-year period, in the following manner:

(1) In the event the actual first cost of the Project as finally determined exceeds the presently estimated first cost, the aforesaid annual payments shall be increased to reflect the actual first cost, including interest during construction, as determined by the Contracting Officer. In the event such first cost of the Project is less than the presently estimated first cost, the aforesaid annual payments shall be decreased to reflect the actual first cost, including interest during construction, as determined by the Contracting Officer.

(2) In the event the annual payments are increased or decreased, as provided above, an adjustment, as determined by the Contracting Officer, of payments made prior to the determination of the final Project cost shall be made in the first payment due after such costs are determined. At the time that the final Project costs are determined, Exhibit "B" shall be modified to reflect the increased or decreased annual payments and such modification will form a part of this contract.

c. No interest will be charged on the investment costs (construction costs plus interest during construction) allocated to the water supply until use is initiated, but such interest-free period shall not exceed ten years. If use is not initiated until after September 1975, (ten years from the time the project was completed and available for water supply services) the interest at the rate of 2.742% from the tenth year until use is initiated may, at the option of the City, be paid annually in order to avoid the long term cumulative effects of such interest. If the interest is not paid annually, the interest from the tenth year until use is initiated will be compounded annually and added to the investment costs to be repaid.

d. The City shall have the right at any time it so elects to prepay its indebtedness under Article 4a in whole or in part; with accrued interest thereon to the date of such prepayment.

e. The annual experienced joint use cost of ordinary operation and maintenance of the project allocated to water supply.

(1) The first payment estimated to be $9,242. will be due and payable when water supply is utilized and payments are initiated; presently estimated to be 1 June 1968 Annual payments will be due and payable in advance on the first day of June thereafter and will be equal to the allocated portion of the actual experienced joint use cost of ordinary operation and maintenance and replacement costs for the preceding Government fiscal year. The second payment shall be increased or decreased in an amount to reflect the difference between the first payment and the actual allocated portion of the experienced joint use cost of ordinary operation and maintenance and replacement costs for the preceding fiscal year. The joint use costs shall be allocated on the basis of 70 percent to the Government and 30 percent to the City.

(2) Records of cost of operation and maintenance of the Project shall be available for inspection and examination by the City. However, the extent of operation and maintenance of the Project shall be determined by the Contracting Officer and all records and accounting shall be maintained by the Contracting Officer.

f. The City shall pay 100% of the cost of specific major capital replacements for the water supply facilities, and 30 percent of the cost of joint-use major capital replacement items and sedimentation resurveys, when incurred. Payment shall be made with the first annual payment becoming due after the date said cost is incurred.

g. In the event of default in the payment of the costs contained in Article 4, a through f, the amount of such payments shall be increased by an amount equal to interest on such overdue payments at the rate of two and seven hundred forty-two thousandths per cent (2.742%) per annum thereon; compounded annually, and such amount equal to interest shall be charged from the date such payments are due until paid.

ARTICLE 5. PERIOD OF CONTRACT

This contract shall become effective as of the date of approval by the Secretary of the Army and shall continue in full force and effect under the conditions set forth herein not to exceed the life of the project.

ARTICLE 6. PERMANENT RIGHTS TO STORAGE

Upon completion of payments by the City, as provided in Article 4 herein, the City shall have a permanent right under the provisions of P.L. 88-140 to the use of such storage space in the project, as provided in Article 1 herein, subject to the following:

a. The City must have discharged its responsibilities for payment of the costs allocated to water supply.

b. The City must continue payment of annual operation and maintenance costs allocated to water supply.

c. The City shall bear the costs allocated to water supply of any necessary reconstruction, rehabilitation or replacement of Project features which may be required to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer. Repayment arrangements including schedules will be in writing and will be made a part of this contract.

d. Upon completion of payments by the City, as provided in Article 4.a. above, the Contracting Officer shall redetermine the storage space for municipal and industrial water supply, taking into account such equitable reallocation of reservoir storage capacities among the purposes served by the project as may be necessary due to sedimentation. Such findings, and the storage space allocated to municipal and industrial water supply shall be defined and described in an exhibit which will be made a part of this contract by supplemental agreement. Following the same principle, such reallocation of reservoir storage capacity may be further adjusted from time to time as the result of sedimentation resurveys to reflect actual rates of sedimentation and the exhibit revised to show the revised storage space allocated to municipal and industrial water supply.

e. The permanent rights of the City shall be continued so long as the Government continues to operate the project. In the event the Government no longer operates the project, such rights may be continued subject to the execution of a separate contract, or supplemental agreement providing for:

(1) Continued operation by the City of such part of the facility as is necessary for utilization of the storage space allocated to it;

(2) Terms which will protect the public interest;

(3) Effective absolvement of the Government by the City from all liability in connection with such continued operation.

ARTICLE 7. OPERATION AND MAINTENANCE

The Government shall maintain and operate the Project owned by the Government. The City shall have the right to make withdrawals of water for its purposes, as needed, in accordance with Article 1. The City shall be responsible for operation and maintenance of all features and appurtenance which may be provided and owned by the City.

ARTICLE 8. TRANSFER AND ASSIGNMENT

The city shall not transfer or assign this contract, nor any rights acquired thereunder, nor suballot said water or storage space or any part

thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without approval of the Secretary of the Army or his authorized representative; provided that this restriction shall not be construed to apply to any water which may be obtained from the water supply storage space by the City and furnished to any third party or parties.

ARTICLE 9. RELEASE OF CLAIMS

The City shall hold and save the Government, including its officers, agencies, and employees, harmless from liability of any nature or kind for, or on account of, any claim for damages which may be filed or asserted as a result of the water supply storage in the Project, or withdrawal or release of such water from the Project, made or ordered by the City, or as a result of the construction, operation, or maintenance of the appurtenances owned and operated by the City.

ARTICLE 10. FEDERAL AND STATE LAWS

The City shall utilize such storage space in a manner consistent with Federal and State laws.

ARTICLE 11. OFFICIALS NOT TO BENEFIT

No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12. COVENANT AGAINST CONTINGENT FEES

The City warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the City for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13. APPROVAL OF CONTRACT

This contract shall be subject to the written approval of the Secretary of the Army and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA

By _____
REMI O. RENIER
Colonel, Corps of Engineers
Division Engineer
Contracting Officer

TWO WITNESSES:

_____
Name

101 Mulberry St
Springfield, Mass.
Address

_____
Name

33 Kittrell Street
Sp'fld, Mass. 01119
Address

THE CITY OF SPRINGFIELD
BOARD OF WATER COMMISSIONERS

_____
Mayor

_____
Chairman

_____
Member

CORPORATE SEAL

APPROVED:

_____
SECRETARY OF THE ARMY

DATE: _____

CERTIFICATE

I, William C. Sullivan, do hereby certify that I am City Clerk of the City of Springfield of the Commonwealth of Massachusetts named herein; that Frank H. Freedman who signed this contract on behalf of the City of Springfield was then and there the duly elected and qualified Mayor of the City of Springfield, that Spiros G. Manolakis who signed this contract as the Chairman, Board of Water Commissioners, was then and there the duly elected and qualified Chairman, Board of Water Commissioners, and that Carson H. Cluley who signed this contract as the Member of the Board of Water Commissioners was then and there the duly appointed and qualified Member of the Board of Water Commissioners, that said contract was duly signed for and on behalf of the City of Springfield and the Board of Water Commissioners by virtue of their authority as Mayor and the Board of Water Commissioners, respectively, and are within the scope of their and the City's statutory powers.

IN WITNESS WHEREOF, I have hereunto affixed my hand and the seal of the City of Springfield the 1st day of February 1968.

City Clerk
William C. Sullivan

CITY SEAL

~~APPROVED:~~

~~SECRETARY OF THE ARMY~~

~~DATE:~~

EXHIBIT A

I - RESERVOIR STORAGES

Feature	Elevation (ft. msl)	Storage (ac-ft)	Percent
Flood Control	518 to 576	23,000	71.00
Water Supply	432 to 518	9,400	29.00
Total		32,400	100.00

II - ALLOCATION OF PROJECT INVESTMENT COST

Flood Control	$5,058,637.57
Water Supply	2,202,160.48
Total	$7,260,798.05

III - PROJECT COSTS ALLOCATED TO CITY OF SPRINGFIELD

Cost of 9,400 acre-feet of water supply storage $2,202,160.48

IV - ALLOCATION OF ESTIMATED OPERATION & MAINTENANCE COST

WATER SUPPLY

	City of Springfield	Flood Control	Total
	$	$	$
Specific Cost	---	7,095	7,095
Joint Cost	9,242	21,563	30,805
Total	$9,242	$28,658	$37,900

V - ALLOCATION OF ESTIMATED ANNUAL CHARGES FOR MAJOR REPLACEMENTS

WATER SUPPLY

	City of Springfield	Flood Control	Total
	$	$	$
Specific Cost	1,245	1,399	2,644
Joint Cost	49	119	168
Total	$1,294	$1,518	$2,812

VI - ANNUAL CHARGES TO CITY OF SPRINGFIELD

Interest and amortization of cost of water supply feature (1)	$105,738.87
24.385 percent of the actual operation and maintenance cost for the preceding fiscal year; computed as follows:	
$\frac{9,242}{37,900} \times 100 = 24.385\%$ Estimated annual amount	9,242.00
29.167 percent of the joint-use cost of major replacement and sedimentation resurveys, when incurred, computed as follows:	
$\frac{49}{168} \times 100 = 29.167\%$ Estimated annual amount	49.00
Total (Estimated)	$115,029.87

(1) Based on 30 payments, 29 of which bear interest on the unpaid balance at rate of 2.742 percent; computed as follows:

$$D = \frac{R}{1 + \left(\frac{1}{i + \frac{i}{(1+i)^{n-1} - 1}} \right)}$$

WHEREIN:

D = annual payment
R = amount to be repaid $2,202,160.48
i = interest rate 2.742
n = number of payments 30

OR:

$$D = \frac{\$2,202,160.48}{1 + \left(\frac{1}{.02742 + \frac{.02742}{(1 + .02742)^{29} - 1}} \right)}$$

which = $2,202,160.48 x .048016 = $105,738.87

EXHIBIT B

Amortization Schedule

Cost of Water Supply for the City of Springfield

TOTAL COST	$2,202,160.48
NUMBER OF PAYMENTS	30
INTEREST RATE, PERCENT	2.742

ANNUAL PAYMENT NO.	AMOUNT OF PAYMENT	APPLICATION		BALANCE
		INTEREST	ALLOC. COST	ALLOC. COST
	$	$	$	$
				2,202,160.48
1	105,738.87	0	105,738.87	2,096,421.61
2	105,738.87	57,483.88	48,254.99	2,048,166.62
3	105,738.87	56,160.73	49,578.14	1,998,588.48
4	105,738.87	54,801.30	50,937.57	1,947,650.91
5	105,738.87	53,404.59	52,334.28	1,895,316.63
6	105,738.87	51,969.58	53,769.29	1,841,547.34
7	105,738.87	50,495.23	55,243.64	1,786,303.70
8	105,738.87	48,980.45	56,758.42	1,729,545.28
9	105,738.87	47,424.13	58,314.74	1,671,230.54
10	105,738.87	45,825.14	59,913.73	1,611,316.81
11	105,738.87	44,182.31	61,556.56	1,549,760.25
12	105,738.87	42,494.43	63,244.44	1,486,515.81
13	105,738.87	40,760.26	64,978.61	1,421,537.20
14	105,738.87	38,978.55	66,760.32	1,354,776.88
15	105,738.87	37,147.98	68,590.89	1,286,185.99
16	105,738.87	35,267.22	70,471.65	1,215,714.34
17	105,738.87	33,334.89	72,403.98	1,143,310.36
18	105,738.87	31,349.57	74,389.30	1,068,921.06
19	105,738.87	29,309.82	76,429.05	992,492.01
20	105,738.87	27,214.13	78,524.74	913,967.27
21	105,738.87	25,060.98	80,677.89	833,289.38
22	105,738.87	22,848.79	82,890.08	750,399.30
23	105,738.87	20,575.95	85,162.92	665,236.38
24	105,738.87	18,240.78	87,498.09	577,738.29
25	105,738.87	15,841.58	89,897.29	487,841.00
26	105,738.87	13,376.60	92,362.27	395,478.73
27	105,738.87	10,844.03	94,894.84	300,583.89
28	105,738.87	8,242.01	97,496.86	203,087.03
29	105,738.87	5,568.65	100,170.22	102,916.81
30	105,738.87	2,821.98	102,916.81	0.00

LITTLEVILLE RESERVOIR

TOTAL CONSTRUCTION COST AND ALLOCATION

OF INTEREST DURING CONSTRUCTION

Water Supply	Construction Cost	Interest During Construction	Total Cost
Specific Costs	$ 173,079.00	$ 6,939.59	180,018.59
Allocation of Joint Use Cost	1,919,784.00	102,357.89	2,022,141.89
	$2,092,863.00	$109,297.48	$2,202,160.48
Flood Control			
Specific Costs	$ 108,905.00	$ 1,004.98	$ 109,909.98
Allocation of Joint Use Costs	4,697,880.00	160,195.48	4,858,075.48
	$4,806,785.00	$161,200.46	$4,967,985.46
Recreation Facilities			
Specific Cost	$ 90,641.00	$ 11.11	$ 90,652.11
		Total	$7,260,798.05

ASSURANCE OF COMPLIANCE WITH THE DEPARTMENT OF DEFENSE DIRECTIVE UNDER TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

The CITY OF SPRINGFIELD, MASSACHUSETTS (hereinafter called "Applicant-Recipient")

HEREBY AGREES that it will comply with title VI of the Civil Rights Act of 1964 (P.L. 88-352) and all requirements imposed by or pursuant to the Directive of the Department of Defense (32 CFR Part 300, issued as Department of Defense Directive 5500.11, December 28, 1964) issued pursuant to that title, to the end that, in accordance with title VI of that Act and the Directive, no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant-Recipient receives Federal financial assistance from the Department of the Army and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant-Recipient by this Department of the Army assurance shall obligate the Applicant-Recipient, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant-Recipient for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant-Recipient for the period during which the Federal financial assistance is extended to it by the Department of the Army.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof, to the Applicant-Recipient by the Department, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The

Applicant-Recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

DATED May 13, 1968

CITY OF SPRINGFIELD, MASSACHUSETTS
(Applicant-Recipient)

BY _____
(Chairman, Board of Water Commissioners)

_____
(Member, Board of Water Commissioners)

_____
(Mayor)

CITY OF SPRINGFIELD, MASSACHUSETTS

36 Court Street or
P. O. BOX 1867, Springfield, Mass. 01103
(Applicant-Recipient's Mailing Address)

Attest:

_____
City Clerk